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Engineers and National Defense

THAT the services for which the country should look to the engineer and the construction man, if the peace of this nation should ever be threatened by a foreign military power, are services for which such men are already trained and available for duty if an intelligent plan of organization is adopted is forcibly brought out in the article by George Perrine on another page of this issue. The suggestion that the construction work necessary for properly insuring our safety, in the light of the present upheaval in Europe, may be begun at once and carried to completion at a low cost by periodic voluntary service on the part of those with experience in engineering construction, is here advanced, as this journal believes, for the first time. It is worth the serious consideration both of those in a position to respond to such a call and of those military and Government officials charged with protecting this country from aggression. Is it too much to ask of contractors and engineers and of the Government that a definite movement shall grow out of this suggestion whereby this country may be made safe at a minimum economic outlay?

New York's Constitution

LAST WEEK'S election carried down to defeat the proposed revision of the New York State constitution. Readers of the Engineering Record are in a general way familiar with New York's efforts during the last six months to revise its basic document, for in connection with the work of the Constitutional Convention a committee of engineers made recommendations as to the proper treatment of departments having to do with engineering work. Much time and effort was spent by the committee of engineers in formulating recommendations for the benefit of the convention. With the exception of one point—the consolidation of several of the engineering departments—the recommendations were not incorporated in the proposed constitution by the convention. So far as the proposed revision itself was concerned, therefore, the work of the committee had already been pretty well lost. Now all of it goes down to temporary defeat. Nevertheless, the committee wrote some documents which should be of very great value in connection with legislative work not only in New York State but in other commonwealths. The principles are generally applicable. Engineering societies should have legislative committees to watch for legislation effecting engineering work and even to initiate it. Such committees will find the conclusions reached by the committee of engineers of help.

Engineers Recognized

IN CONNECTION with the publicity which the Lackawanna Railroad is now giving its new cut-off, it is gratifying to note that the engineers responsible for the work are given due credit. While one would have expected that their names would be mentioned in the general descriptions sent out by the railroad to the newspapers on the day of the opening of the new line, it is contrary to railroad practice to give credit in the company's descriptive circulars. Nevertheless, this is what the Lackawanna has done. In descriptions of the cut-off included in the new timetable Mr. Ray, as chief engineer, and Mr. Wheaton, as engineer of construction, are given credit for the gigantic work. It is a move in the right direction. Railroad practice is to keep the engineer in the background, to look on him entirely as a subordinate, and to put the financial and traffic departments in the limelight. A shift of the light now and then to the engineering department would give deserved credit and much encouragement.

Danger!

NOW that the fall and winter months are upon us, with the possibility of concrete failures due to negligence or criminal ignorance of the effects of cold weather on strength, both words of caution and test conclusions are timely. The words of caution will be found on page 556 of the Engineering Record of Oct. 30, abstracted from a poster printed by a prominent concrete company. They contain good rules for preventing failures, particularly with reference to the removal of forms. Results of laboratory tests showing variations in strength of concrete with curing temperature are given on page 600 of this issue. They show conclusively and with convincing uniformity that the strength varies directly with the increase in curing temperature, and that the loads which comparatively green concrete can support when the curing temperatures are near the freezing point may be only one-half as great as the normal allowable values. The weakness of low-temperature concrete must be realized by all contractors. Engineers and building departments have an obligation to spread this knowledge and to insist, where they have authority, upon extra precautions, such as the heating of materials and the protection of the work after pouring, wherever winter concreting is allowed. The facts regarding cold-weather concreting are too well known to allow any plea to set aside a charge of criminal negligence if life is lost or serious injury sustained, due to neglect of the necessary precautions. Fortunately the number of failures last winter was smaller than those of previous seasons—an indication that warnings are not going unheeded. If engineers and building departments will do their part in helping to educate the contractor, there will be still fewer failures this year.

Preparedness for Ice-Fighting

REPETITION of the usual warning against the dangers of winter concreting is a reminder that now is the time for drawing up instructions as to the procedure in ice-fighting at hydroelectric plants exposed to ice difficulties. As in military matters, or any occupation where forces must be marshalled quickly and used instantly with maximum effectiveness, careful detailing at leisure is the only way to insure success. There is time yet, before severe weather conditions come, to pore over the ice-run records, to discuss with station operators the peculiarities of ice conditions at the plant in question, to learn what other stations have done and then lay out, definitely and step by step, the procedure for keeping the plant in operation no matter how vigorous the ice assault. As a basis for the directions, plants which have no instructions at the present time would do well to study carefully the two articles by F. A. Allner, general superintendent of the Pennsylvania Water & Power Company in the Engineering Record of July 17, and July 24, 1915, pages 66 and 113. The procedure adopted at the Holtwood plant proved its efficiency last winter, and, with the additional precautions included in the instructions as a result of last year's experience, should keep the plant in service without serious danger of interruption under the most adverse conditions to be expected.

Casting Bread on the Waters

OPPORTUNITY knocks at the doors of the four agricultural schools and the State University of Arkansas. Its State highway engineer, H. R. Carter, has appealed to the Legislature in his recent biennial report to provide means whereby students at the State colleges may come to a better understanding of modern road construction, and the benefits to be derived therefrom. In order that this may be accomplished, he suggests that rock for experimental roads be furnished free by the State. The counties in which the schools are located are to do the grading and the handling of the rock, assisted by the labor of the students of each school. The State highway engineers will be sent free on request and plans and specifications furnished gratis. Perhaps it is too much to expect the students to spend time as laborers on the road, but it might well be made compulsory for every student to include in his studies the subject of modern road construction. In a State which has only 3 per cent of its 36,000 miles of road improved, where education on the subject of better roads is sorely needed, the colleges have an excellent opportunity to send broadcast into the State each year hundreds of young graduates who, by actual experience and study on the subject, can awaken the dormant conscience of its rural population and stimulate a desire for road improvement. The colleges will not be casting their bread on the waters in vain, for a gratified rural legislature will surely reward their efforts with increased appropriations.

Good and Bad Regulation

THERE is a widespread idea that because railroad men are opposed to some regulation they are opposed to all. Members of the Western Society of Engineers had an opportunity Nov. 2 to hear otherwise from L. E. Johnson, president of the Norfolk & Western Railway. Mr. Johnson not only favors regulation, but considers it the only alternative to government ownership—but it must be "wise and fair." He holds that the regulation should be centralized in the Interstate Commerce Commission, which should have higher-salaried members appointed for life and empowered to do much of the regulating now done by Congress and by State commissions and legislatures.

The State commissions would confine their activities to purely local matters. To Mr. Johnson "there cannot be any good reason for applying widely different and wholly inconsistent requirements in States adjacent to each other, such as Nebraska and Kansas, or Massachusetts and Connecticut; and there certainly cannot be any good reason why a State government should apply one rule in a State and the Federal Government should apply an entirely different rule in the same State. . . . There can be no good reason why a State passenger should be allowed to travel for 2 cents a mile in a State when the Interstate Commerce Commission has held that 2½ cents is a reasonable rate for interstate travel in that same State. . . . There can be no good reason why a State law in Texas, for example, should prescribe certain hours of work for railway employees engaged in State commerce when a Federal law prescribes different hours for all railway employees engaged in interstate commerce. . . . There can be no good reason why the Interstate Commerce Commission should hold that the earnings of the railways in Eastern territory are not as large as they should be in the interest of the public, and that at the same time the States should be allowed to prevent the increases in earnings which the Interstate Commerce Commission holds should be permitted in the interests of the public."

Mr. Johnson pointed out that the country ought to regard railroad securities as safe and advisable investments for people of small means, but that the protection of the investor had been largely overlooked in the protection of the traveler, the shipper and the employee. Regulators need to be equally zealous in guarding the welfare of all of these interests. Such impartiality was hardly typified, however, as Mr. Johnson suggested, by the appearance of sixteen State commissions against the railroads in the recent Western rate case. This journal has already commented on the arraying of the State commissions against the railroads at the Federal conference on valuation in Washington last May.

The most enlightened railroad men do not oppose all regulation. They oppose only unfair regulation. They believe that the same body that fixes maximum rates should be authorized to fix minimum rates. They do not think it fair for the Government to establish a maximum fair return on the investment without giving some sort of assurance of a minimum return; to deny rate increases and then wash its hands of wage increases obtained by the unions at the pistol point. They think State regulation should not be such as to subject them to suit under Federal laws for discrimination. In short, what they ask is a competent centralized authority that, to quote Mr. Johnson again, "will confer the maximum benefits on each class that is directly interested and on the public as a whole" and "will equally consider the rights and interests of the traveler, the shipper, the employee and the investor."

The Draft Tube—A Neglected Feature of Hydraulic Design

PRACTICE in the design of hydroelectric plants has become very refined in recent years. With the steady and phenomenal climb in turbine efficiencies has come searching examination of all details which might rob the installation of even a fraction of 1 per cent efficiency. This searching examination has extended practically to every feature of the plant, but it may well be questioned whether the same scientific examination has been given to draft-tube design as has been accorded other features. For that reason the Engineering Record directs attention to the series of two articles by A. G. Hillberg, which begins in this issue, page 604.

Mr. Hillberg advances one theory which, if his observation and reasoning be correct, should answer a very baffling question in hydroelectric station practice. As is well known, vibrations in such stations have long been the subject of investigation. Many engineers believe that they are due to certain defects in mechanical details of the wheels, as for instance the location of the bearings. In large, vertical, well-designed, single-runner units, however, operating under comparatively low heads, it is unlikely that the shaft is responsible. The runner itself is well-balanced, so well, in fact, that a few years ago a large runner, weighing 130,000 lb., when supported on a horizontal shaft was set in motion by a 5-lb. weight on the periphery. The generator rotor is equally well balanced. The shaft connecting them is generally short, from 20 to 30 ft., and from 20 to 23 in. in diameter. On this shaft there are at least three steady bearings, one directly above the crown plate of the runner and the other two located below and above the generator rotor. In addition there is a thrust bearing, which can be located either above the generator or between it and the runner.

Some engineers, while conceding that the location of the steady bearings on these short shafts cannot be held accountable for the vibration, contend that the design in which the thrust bearing is placed on top of the generator is a contributing factor. As to this there is probably still room for argument, but the very general acceptance of this type of design, even for large units, seems to indicate that engineers generally would not charge this feature of design with the difficulty in question.

It is Mr. Hillberg's contention that the vibrations originate in the draft tube. The water discharged from low-head turbines sometimes measures as much as 3500 sec.-ft. If this stream, flowing at a velocity of 15 to 20 ft. per second, does not fill the draft tube, vibrations are to be expected. The fact that in certain installations it has been observed that vibrations increase with the gate opening would tend to support Mr. Hillberg's theory.

The method, therefore, based on the theory that the change in velocity head should be less than the corresponding change in elevation has much to commend it. If Mr. Hillberg's views as to the source of the vibration are correct a design based on this theory would obviously tend to prevent the trouble. There is one apparent objection to a tube designed in this manner; the rapid increase in area of the lower part would make the center to center spacing of wheels rather large.

It is apparent that the desideratum in hydroelectric design is not merely to secure a high-efficiency wheel, but to set it in such a fashion that the over-all hydraulic efficiency of the unit will be high. The draft tube is therefore an important factor. How serious its influence may be was shown in a Middle Western installation in which two different designs of draft tube were used. One was designed by the consulting engineer, the other by the turbine manufacturer. The over-all hydraulic efficiency of the unit installed with the draft tube designed by the former was about 5 per cent higher than the wheel set in the manufacturer's tube.

In another case the designer of the draft tube calculated the sizes required for the top and end areas, and then figured each intermediate area on the basis that the draft tube, when developed along its center line, should be a frustum of a cone. In other words, the developed tube would have a straight flare. In this plant it has been found dangerous to overspeed the wheels because of the excessive vibration.

Mr. Hillberg's articles should direct closer attention to draft-tube design. Already careful and able hydraulic designers are giving the matter close consideration, but the importance of handling the discharge water with least loss of efficiency is one that should be more generally appreciated.

Organizing Industry for National Defense

TO ORGANIZE the industries of the nation and to standardize all the equipment needed for 1,000,000 troops in such a way that manufacturers upon receipt of a telegram from the Secretary of War would within one day start to turn out and deliver material almost as fast as it could be taken from storage—that is the Gillen plan for an industrial general staff. Careful study of the plan fails to reveal any reason why such an organization is not entirely feasible in principle.

The details of the plan are entirely too long to repeat here. In effect it provides for a civilian general advisory board of experts selected from the industries which would supply the different materials needed by the Government. The board would be under the direct control of the Secretaries of War and the Navy. Representatives from the war, navy, quartermasters and justice departments would be members of the board. Other members would be elected by a group of at least five representatives from each industry, these representatives to be appointed by the President. The purpose of the group is to have a definite entity with which the Government can confer. The groups would co-ordinate and standardize specifications in accordance with factory equipment and raw materials available. Dies for irons used in the manufacture of the wagons, for example, would be made by the Government and sample wagons by the manufacturers. Data as to names of companies, capacity and delivery possibilities are to be collected with a view to preventing confusion and to getting competitive prices and quick delivery. To keep the plan alive the Government would call for bids from each group every six months on war needs for from 500,000 to 1,000,000 troops. Contracts would be made immediately but fulfillment would wait upon the word of the Secretary of War.

Of special interest to the engineer is the inclusion of waterworks and sewerage as "industries." The work of the group in this case, according to the plan, would be quite largely to educate its members in army regulations, camp-site selection and sanitation. Control of the railroads would be effected by a group of railroad presidents. An ingenious method of mobilizing motor trucks and of converting 50,000 pleasure cars into trucks without any prior investment of money are details well worked out. No mention is made of road builders or the advantage of co-ordinating present road construction with military requirements. For instance, the very great desirability and necessity of completing the many short links now separating large cities before building further isolated stretches of road could well receive the attention of a civilian "group" co-operating with army officials.

To Martin J. Gillen, president of the Mitchell Wagon Company, Racine, a large amount of credit is due for putting in concrete form a subject which after-dinner speakers are beginning to wear threadbare with repetitions of generalities. Among the 15,000 recipients of copies of the plan are practically all the interested corporation officials in the country. Of the 600 replies, only three considered the idea of no value. The others believed it meritorious, and many of the suggestions offered have been incorporated in a revised draft of the plan.

Mr. Gillen sums up the question squarely in the following words: "Either this nation is strong enough to fearlessly plan with suppliers and regulate them for its own protection during times of peace, or cowardly repose in the full realization that in event of war pull, graft, confusion, lack of supplies and improper preparedness will cost this nation many lives, hundreds of millions of dollars and may be national honor."

Relation Between City Planning and Municipal Research

SHOULD city planning commissions have executive or merely advisory functions? This is a question which is coming to the front and one which has already begun to create discussion. It was made prominent by two papers presented at the Seventh City Planning Conference held at Detroit in June. Dr. Robert H. Whitten, of New York City, emphatically favored advisory commissions, while Mr. Thomas Adams, Town Planning Adviser of the Canadian Commission of Conservation, urged for commissions with more power.

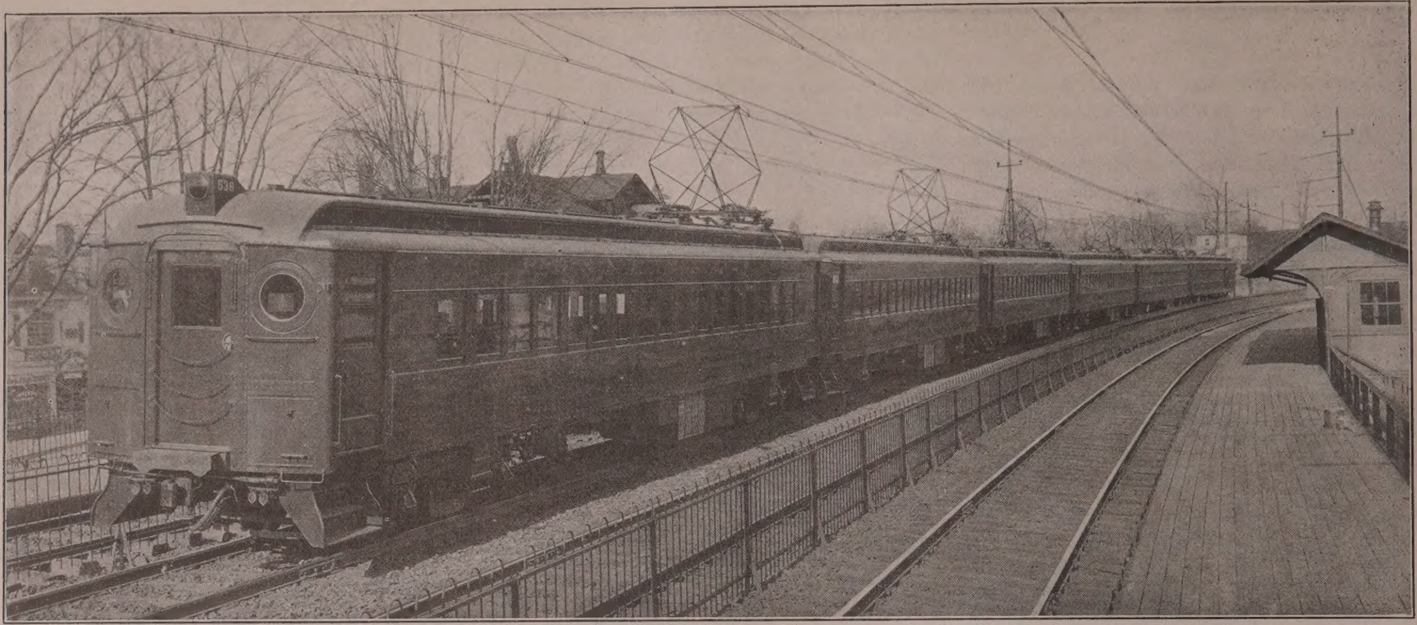
It may be admitted at the outset that the idea of having a plan for a city or town is fundamentally sound. Those cities have developed best which were laid out on broad and expansive lines by men who, while they could not foresee the future, could appreciate growth. But there is something else that is just as important as having a plan, and that is, adhering to the plan after it has been made. In fact, there are three steps—making the plan, adopting the plan and carrying out the plan. The first is a matter of expert thought, the second is a matter of legislation, the third is a problem of administration. The question therefore presents itself in this form: Should a planning commission confine itself to the first phase of the subject, namely that of studying the local community from all points of view and developing a plan to be accepted or rejected by the people, or should the commission be made an integral part of the machinery of government and be given the broader powers of enforcement? There are no doubt sound arguments in behalf of both ideas, but it is certain that the latter course is not likely to be popular with either the legislative or the administrative officers. Even where planning commissions confine their activities to the formative stage they are met with coldness and adverse prejudice. If city planning is to make sure progress the causes for this unsympathetic attitude must be removed.

A planning commission in order to pursue its work needs to have before it all sorts of information in regard to the city or town and its people. Data must be obtained from the various departments and right here comes the first rub. Often the facts are not at hand, or, if existing, cannot be put together in the form desired without extra labor on the part of the various departments. The planning commission then becomes a sort of bureau of municipal research and comes to be regarded as an inquisitional body. Weak spots in administration may be discovered in this way, but the benefits are beside the issue. Again there is a tendency for permanent planning commissions to desire to become repositories for the data collected, thus supplanting or duplicating the work of the regular administrative departments. This in the end is bound to be destructive of the main work. There is indeed grave danger lest the whole movement run on the rocks through the arousal of petty jealousies toward over-zealous planners, and that the plan itself become obscured in the minds of the public by a maze of detail.

How may this be prevented? One way would be to have the planning board include in its membership some of the heads of the administrative departments. This would not only forestall the jealousies resulting from outside interference, but would incite enthusiasm for municipal work as a whole. After all, are not the city engineers as a class the most competent of city planners for their communities, and is not a planning commission without its official engineer member a case of Hamlet with Hamlet left out? But with the city officials should be associated other persons, able citizens, representatives of industries, business, capital and labor if a plan acceptable to all the people is to be secured. This might mean a large membership, with a working committee, or a small commission with a large advisory board. The questions raised are so important to the success of the movement that in these days when legislation is beginning to crystallize it is important to study the trend of events to make sure that they are leading toward the desired goal.

Planning commissions should not become bureaus of research. Their mission is broader, and although the results of surveys are desirable and even necessary to city planning, the greater issue should not be obscured by the less. Better policy would be to put the collection of the necessary data in the hands of one expert who would know the facts needed in any particular case.

Finally, just what is meant to-day by a city plan? Is it the arrangement of streets, a division of the area into channels for transportation, parcels of land for private uses and other parcels for parks and public uses, or is it something broader? Does it include all of the physical city—houses, sewers and water pipes, and so on? There seems to be a tendency to the adoption of the broader view. But there is a great danger of over-reaching, and in attempting to do too much nothing may be accomplished. We are coming to regard city planning as something desirable and worth while. We have had comprehensive definitions of city planning, but who will define what is meant by a city plan? Is it like the system of harbor lines set by the government, or something more?



TYPICAL ALL-STEEL PASSENGER TRAIN—EACH COACH HAS ITS OWN MOTOR EQUIPMENT AND PANTAGRAPH

Pennsylvania Inaugurates Electric Service in Philadelphia

Running of Electric Suburban Trains Between Broad Street Station and Paoli First Step in Electrification of District—To Increase Rush-Hour Capacity of Terminal 8 Per Cent

ELECTRIC TRAINS are now being operated by the Pennsylvania Railroad in Philadelphia. The substitution of electric for steam power for the suburban train service between Broad Street Station and Paoli marks the completion of the first step in the electrification of the Philadelphia district. The electrification of another suburban line has already been started. The main purpose of the change in power is to increase the capacity of the Broad Street Station and relieve the congestion at the terminal. The Paoli service is operated by the overhead system at 11,000 volts, single-phase, 25 cycles, the railroad company buying the power. The trains are multiple unit, each car being a motor.

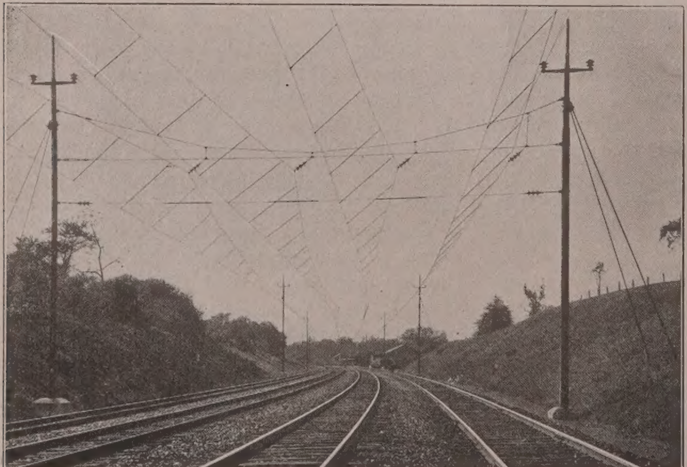
PURPOSE OF IMPROVEMENT

Broad Street Station is of the stub type, with sixteen station tracks approached by six main-line and three yard tracks on an elevated railroad which crosses the Schuylkill River from West Philadelphia, at which point the routes divide for New York to the north, Washington to the south, and Pittsburgh to the west. In addition to the through passenger service there is an extension suburban service extending over six different routes. The growth of all business in recent years has been such that the limit in capacity of the station has been reached, and many plans have been formulated and discussed for relief by physical enlargement of the station and its approaches, or by re-routing movements. All of these plans involve extensive reconstruction, and would require much time for their accomplishment, so that some more expeditious method of obtaining relief was desirable. The possibilities of electric traction as a means to this end were examined into by committees of operating officials of the road, and their analysis and estimate indicated that during rush hour the relief which would be secured by the electrification of the suburban Paoli service alone would be equivalent to increasing the station capacity by an amount equivalent to 17 or 19 per cent of the Paoli service, and for the station as a whole to that accomplished by reducing the total number of trains about 8 per cent. A similar increase in capacity would result for the electrification of other suburban lines, and work in connection with one of these, namely, the Chestnut Hill service, has already been started.

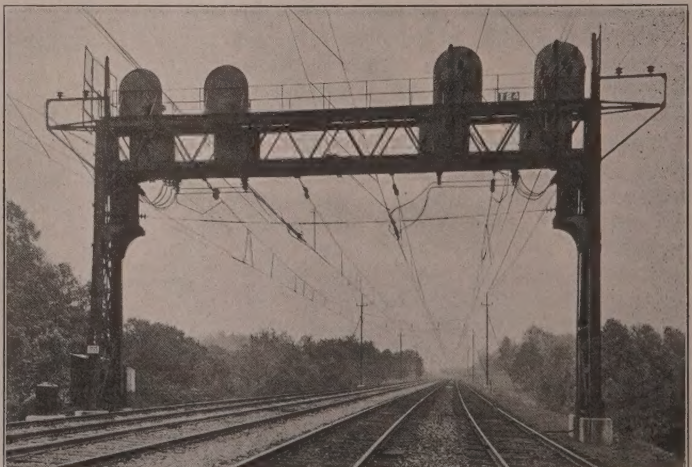
CAPACITY INCREASE

This increase in capacity is effected by the elimination of switching and movements of empty power, and also by the quicker acceleration of trains and shorter length of track occupied when the steam locomotive is omitted. The relief thus afforded by the electrification of the Paoli and Chestnut Hill lines is estimated to be sufficient to take care of the normal growth of business for the next seven or eight years.

It is estimated that under electric operation there will be sufficient saving in operating costs as compared with steam to pay interest on the investment, which in this case includes the entire Broad Street ter-



TUBULAR POLES USED WHERE ROOM FOR BRACING WAS AVAILABLE—NOTE WARPING OF CATENARY SYSTEM ON CURVE



SEMAPHORES REPLACED BY LIGHTS OUTLINING SIGNALS IN THREE POSITIONS—BOOSTER TRANSFORMERS ON BRIDGE minal. This means that the increased capacity will in part, at least, be self-sustaining, whereas increased capacity by physical enlargement would give no direct return upon the investment. In addition there are the other advantages of electrification, such as higher speed of trains, more comfortable service, especially in bad weather, and cleanlier and more attractive conditions for the traveling public.

CHOICE OF SYSTEM

Analysis of service conditions and cost estimates covering all available electric systems led to the conclusion that one using a very high voltage, overhead contact wire and one eliminating moving machinery in substations would be the most suitable and economical as to both first and operating costs. Primary importance was attached to the feature of possible long-distance operation over the entire division affected, rather than to the requirements for present short suburban electric service. The system adopted is 11,000-volt, single-phase, 25-cycle power supplied direct to the trains from the overhead catenary trolley system.

The present installation covers the suburban passenger service only and involves about forty-three trains each way per day from Philadelphia westerly to Paoli on the main line of the Philadelphia division. The main tracks are electrified for 20 miles, and the improvement includes a coach yard at West Philadelphia and a coach and repair yard at Paoli. In all 93 miles of track are embraced in the present electrification.

Power is purchased from the Philadelphia Electric Company and is generated in their main station on the easterly bank of the Schuylkill River about a mile south of the West Philadelphia passenger station. The power is delivered to the railroad company at 13,200 volts, whence it is stepped up to 44,000 volts and transmitted to the step-down substations, of which there are three. The step-up substation is on the west bank of the Schuylkill River opposite the electric company's power house. The step-down stations are at West Philadelphia; Bryn Mawr, about midway on the improvement; and Paoli. Along the right-of-way the transmission lines are carried on the catenary system.

CATENARY SYSTEM

The power system is similar to that used on the Norfolk & Western electrification, described in the Engineering Record of June 5, page 704, and in its main features the catenary system is like that of the Norfolk & Western. In order to try out the various types of structures and details considered for the work, an experimental four-track section about one mile long was completely equipped in the fall of 1913. Study of this led to the adoption of what is known as the tubular cross-catenary bridge for carrying the catenary trolley wires. On either side of the track a tubular steel pole is set and grounded into a concrete foundation. Each pole has a double guy anchoring the pole away from the tracks, and spanning the track between the poles are the two cross wires forming the cross-catenary bridge which carries the longitudinal wires. This type of structure has been used throughout wherever the property or arrangement of tracks would permit. Where there was no room or guying, self-supporting structural steel poles have been used. (The tubular poles were also used on the Norfolk & Western work, but the smaller number of tracks made it possible to use cross girders for the most part instead of the cross catenaries.)

TUBULAR POLES

The tubular poles are built up of various lengths, sizes and weights of steel pipe welded together, different heights and lengths being required to suit the varying conditions at the different locations. The guys are solid steel rods with a heavy turnbuckle near the ground end to permit of adjustment. Numerous experiments and tests of different forms of guy anchors were made to determine the holding power and economy, and the anchor adopted is of the dead-weight type, consisting of a concrete slab reinforced with old rails held in place by the weight of the soil above. Where the guy rods pass up through the soil they are protected against corrosion by means of a steel pipe, the space between pipes and rods being filled with grout. Each catenary structure is grounded by means of a copper plate buried in coke.

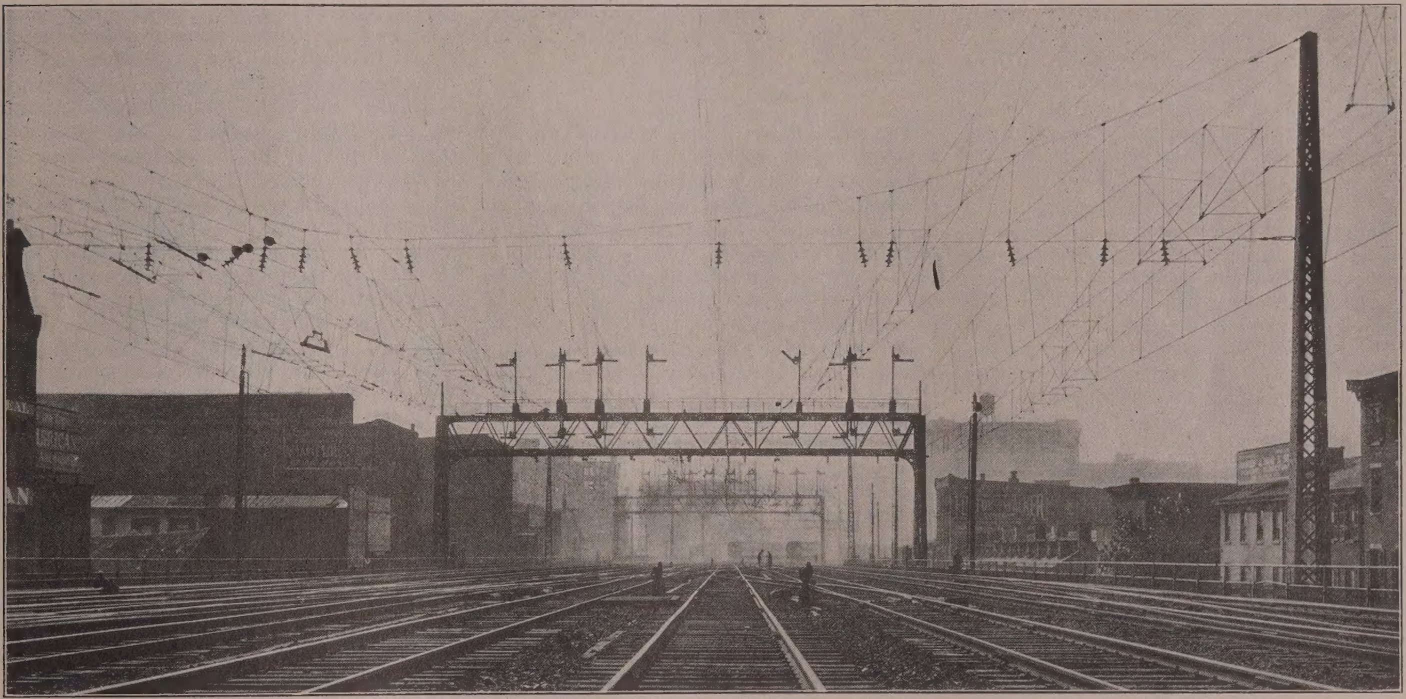
WIRES

The cross wires are of extra-high-tension galvanized-steel strand, the upper strand usually being ¾ in. and the lower one ½ in. in diameter. Both are socketed at each end and at one side a turnbuckle is installed. The top and bottom cross wires are joined together by means of a vertical ¾-in. rod and suitable malleable iron clamps, etc., at the point where insulators carrying the longitudinal wires are located.

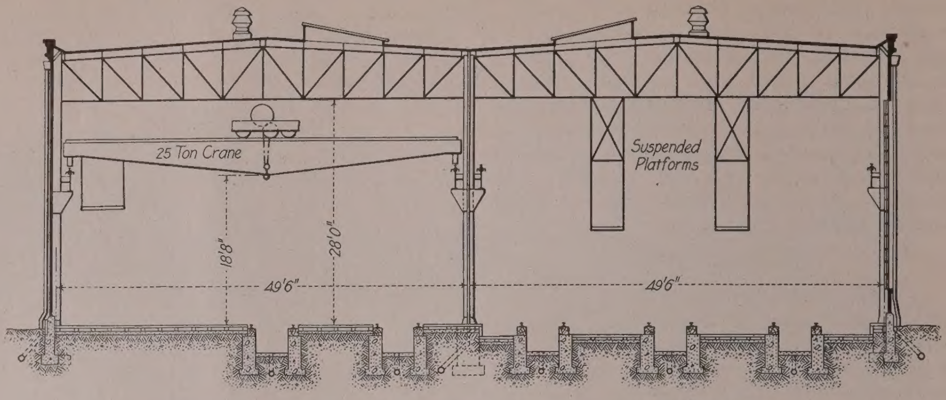
As in the Norfolk & Western work the cross wire bridges are located about 300 ft. apart on tangents, but are closer together on curves, the exact spacing depending on the degree of curvature. After the bridges are erected insulators are suspended approximately over the center of each track, these being precisely over the center of the track on tangents, but offset toward the outside of the curve on curved track. After the insulators are erected the main messenger wire is strung out and suspended from them. This is a ½-in. extra-high tension, seven strand, double-galvanized steel cable, having a sag of 5 ft. in a span of 300 ft. Every mile or two this messenger is socketed and dead-ended on one of the heavy structural signal bridges, which are spaced about ½ mile apart.

HANGERS

Every 15 ft. on curved track and 30 ft. on tangent track a hanger supports the lower two wires from the messenger wire. The upper of the two wires, called the auxiliary messenger, gives suitable current capacity to the system. The lower one is the contact or trolley wire. Both are carried in a vertical plane generally about 22 ft. above top of rail.



OVERHEAD WORK FOR TANGENTS AND FOR CROSSOVERS—STRUCTURAL STEEL POLE AT RIGHT OF PICTURE



CROSS-SECTION OF CAR INSPECTION BUILDING IN PAOLI YARD

In the Terminal division, which includes the first 5 miles from Broad Street Station, where the steam locomotive traffic is very dense, resulting in much smoke and corrosive gases, a non-corrodible tube hanger is used. Some of the tube is Monel metal, while the balance is a bronze mixture containing 90 per cent copper. The tube has an outer diameter of 9/16 of an inch. On the Philadelphia division, where there is relatively less traffic, wrought-iron strap hangers 1 x 3/16 in. are used.

On tangents the casting at the bottom of the hangers holds the auxiliary messenger only, and the trolley wire is, in turn, supported from the auxiliary messenger every 15 ft. at points equally distanced from the hanger. This insures a very flexible trolley wire.

On curves the two lower wires do not hang directly beneath the messenger, but the whole system swings into a curved plane until a balance is reached between its weight and the tension in the wires. The tensions in both the auxiliary messenger and trolley wires are selected, so that in extreme hot weather there will be enough tension to prevent sagging, and yet in extreme cold weather the contraction will not cause stresses beyond the elastic limit.

SECTIONALIZING

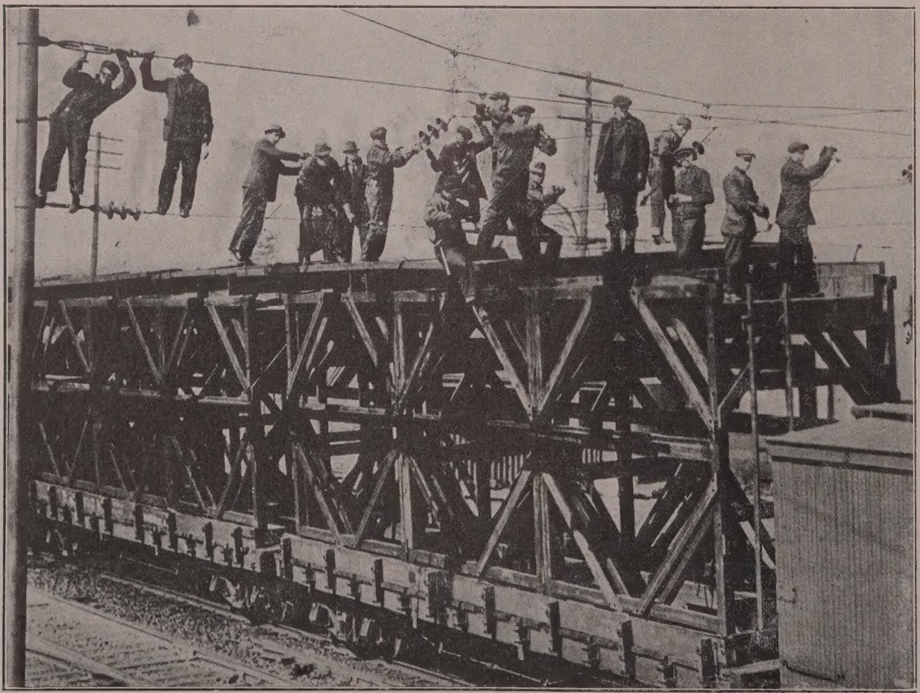
The catenary system over each of the four main tracks is separated electrically from those over the other track, and trolley sectionalizing points with switches are provided at all crossovers so that sections of the line may be temporarily cut out of service for repairs. On the main running tracks sectionalizing is of the "air-break" type, the trolley wire being divided into two wires which are spread apart, and each wire being lifted up at a different point. Insulators are placed in each wire where it hangs above contact with the pantagraph; that is, while the pantagraph is making contact with one wire the other is lifted up and sectionalized. At crossovers and in yards the trolley wires are sectionalized by means of wood stick insulators, having runners or gliders on each side so arranged that while the pantagraph always makes contact with at least one of these levers they are separated electrically.

Several of the accompanying illustrations, as well as that on the front cover, show the different forms the catenary system takes on tangents, over curved tracks and in yards.

ERECTION CARS

The cars used in the erection of this catenary work had top platforms which could be readily raised or lowered by means of chain hoists. They were also equipped with removable outriggers, so that in the four-track section the work could be completely erected over one of a pair of tracks without in any way interfering with the regular steam traffic on this track.

The electrified route is crossed in many places by overhead highway bridges, some of which are not high enough above the tracks to permit the trolley being carried at the normal height of 22 ft. At such points the trolley wires gradually dip and go under the bridges at a lesser height. The catenary bridges are so located that these highway bridges come in the center of a span where, due to the sag in the messenger, the vertical height necessary to clear the system is a minimum. At such bridges the system is steadied by being held with post-type insulators supported by brackets on the bridge structure.



CARS FOR OVERHEAD WORK HAD ADJUSTABLE PLATFORMS AND OUTRIGGERS

In order to minimize the inductive effect of the traction currents on adjacent telephone and telegraph wires, a special system has been installed. This consists of series or booster transformers located about a mile apart. These transformers are mounted on signal bridges, and the current in each of the trolleys is constrained to pass through a primary coil of the transformer, thus inducing an equal current in the secondary coil, the ratio of the transformers being approximately unity. The secondary coils of these transformers are connected across insulated joints in the track, and consequently, as all trolley current must flow through the primary coil, the secondary coil insures that all the returning traction current, at this particular point of the circuit, at least, must flow through the rail. In this manner the traction current is prevented from taking earth returns in parallel with the track, or if there be a tendency between these booster transformers for the traction current to seek an earth return, this is corrected at the next booster transformer, which constrains or picks up all the traction current and again starts it through the rail.

ROLLING STOCK

Standard suburban steel coaches of the type used in the regular steam service have been used for the electric service without structural changes. This was made possible by the fact that the requirements for mounting electric apparatus on the cars had been thoroughly considered at the time when the steel car was introduced upon the railroad. The rolling stock consists of ninety-three standard all-steel cars, of which eighty-two are passenger, nine combination passenger and baggage, and two combination baggage and mail. All cars are motor cars, as no trailers will be operated in this service. The equipment of each car consists of two 225-hp. motors and automatic multiple-unit electric air-brake equipment. All the main fixtures of the electrical apparatus are mounted on one end of the car, and the air-brake equipment on the other, giving a slightly uneven weight distribution on the two trucks. The cars are designed for double-end operation.

The pantagraph is of especially light construction. The springs which raise it are designed to give flexibility to the framework, so that in operation a slight dragging of the trolley takes place, resulting in its following the wire much closer than with a rigid framework. In addition the shoe is spring mounted on the framework. The trolley is provided with four insulators suitable for 11,000-volt service, and the whole mechanism is mounted on a case provided with insulators similar to those of the trolley, which gives it a double insulation.

In connection with the pantagraph the safety-first principle has been carried out in the provision of a grounding device of novel design. Steps for mounting to the roof are provided at one corner of the car only, and a lever is placed on the roof at this corner. When one climbs to the roof of the car this lever is thrown up, thus locking the trolley in the down position and grounding the entire framework.

The air-brake equipment is designed so that it may be used either in steam or electric service, and differs from the ordinary pneumatic brake in that the brake pipe reduction is made on each car by means of electric control instead of being made entirely with the engineer's brake valve. The addition of electric control to the pneumatic brake does not change its function in any way, but shortens the time required to get the brakes applied on all cars.

Trains of from two to seven cars are operated in regular service, the average acceleration on a straight level track being approximately 1 mile per hour per second up to 30 miles per hour, with a balancing speed of 60 miles per hour.

A substantial and completely equipped car inspection building has been constructed at Paoli yard. A cross-section of this building is shown. It is planned to serve not only the cars required for the present electrification but also those required by certain other divisions when electrified.

CHANGES IN SIGNAL SYSTEM

Throughout the electrified zone it was necessary to change the existing direct-current track circuits to alternating-current track circuits and to provide impedance bonds, which permit the return of the 25-cycle traction current, but sectionalize the various track circuits so far as the 60-cycle current is concerned. In the electrified part of the Philadelphia division about 15 route miles, all four-track, the old form of semaphore signals has been replaced by those of the electric light type in which different rows of lights, each with suitable lenses, indicate the various positions of clear, caution and danger. A view of one of the typical signal bridges with the new type of signals is shown.

WIRE CONDUIT

Following the heavy sleet storm of March, 1914, which caused so much damage to the overhead wires in the Eastern States, the railroad company decided to put certain parts of their telephone and telegraph wires under ground, and this has now been done throughout the electrified zone. The absence of the usual overhead telephone and telegraph wires along the right-of-way will be noticed in several of the photographs.

Along the main line this underground conduit consists of six single ducts, 3-in. bore, part of clay conduits, and part of bituminized fiber. The conduit bank is protected with concrete on all sides. There are concrete manholes every 400 ft. or less. In order to minimize inductive disturbances from the traction circuits the conduit is located as near the edge of the right-of-way and as far from the track as practicable, although in some cases it is just beyond the ends of the ties on the outside track.

PERSONNEL

The design and construction of the electric installation was carried out by Gibbs & Hill, consulting electrical engineers for the company, in co-operation with the engineering department and the officials of the railroad. All construction except that of substation buildings and inspection building, which were covered by outside contracts, was carried out by a specially organized force. The mounting of the multiple-unit car equipment on the cars was carried out by the railroad forces at the Altoona shops, under the direction of the motive-power department. The signal equipment and changes in telegraph and telephone lines were designed and installed under the direction of the signal and telegraph departments respectively.

No less than twenty-four manufacturing companies supplied important items on plant or equipment for the installation. The Westinghouse Electric & Manufacturing Company furnished the motor car equipment and transformers; the National Tube Company supplied the tubular poles; the structural poles and bridges were furnished by the McClintic-Marshall Company, while the J. A. Roebling's Sons Company, the Waclark Wire Company and the Bridgeport Brass Company supplied the transmission, messenger and trolley wires.

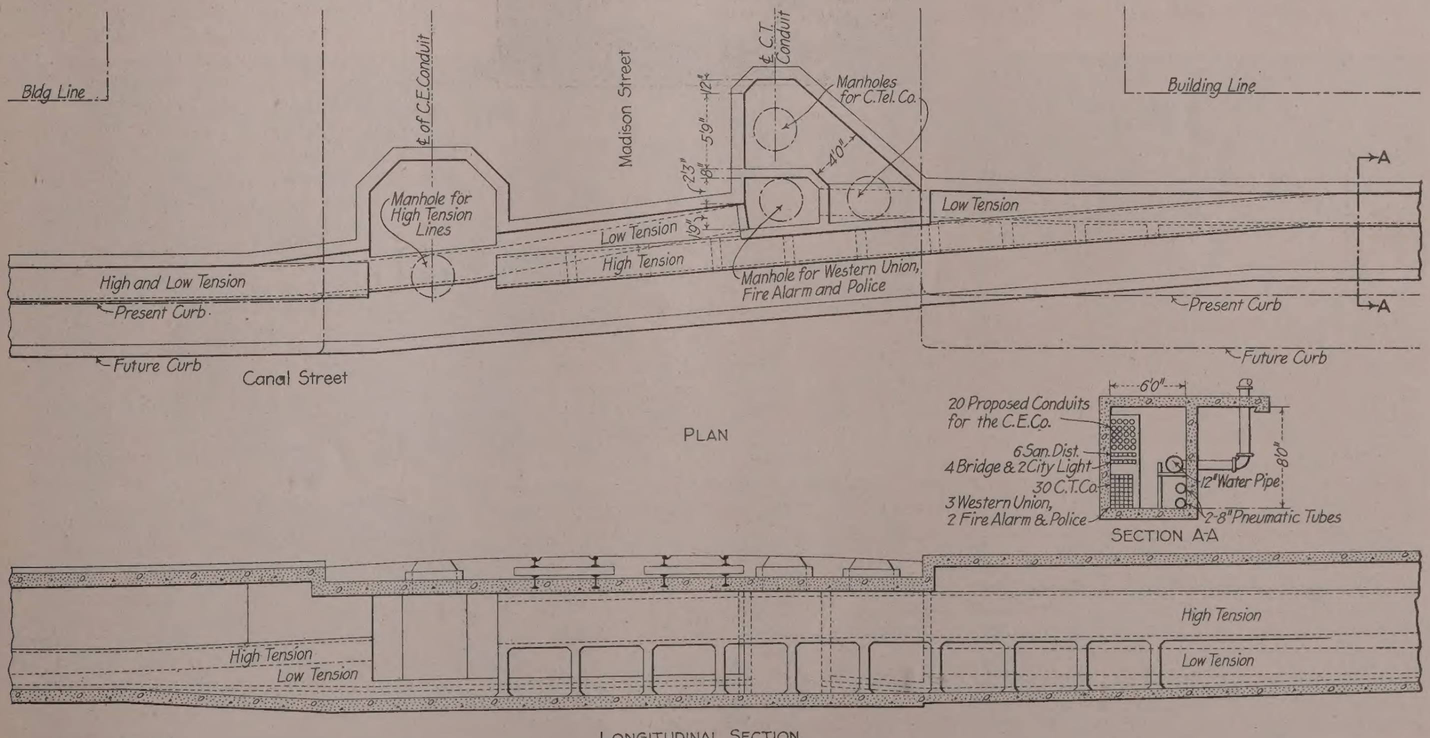
Chicago Builds Its First Utility Gallery

Construction of New Union Station Aids in Bringing Co-operation Between City, Public Utilities and the Station Company, Making the Project Feasible

CHICAGO is to have a model public-utility gallery. Co-operation between the city authorities, the new Union Station Company and the public utility companies has made this possible. This will be the only gallery of its kind in operation in this country, it is believed; New York built one in connection with the Bridge Loop Subway, but its use has been insignificant.

ERECTION OF NEW STATION AIDS

The erection of the new Union Station furnished the opening wedge for the city officials to urge the new type of construction, as the station company is required to rearrange at its own expense the underground service pipes and wires of the city, as well as those of other public utilities. At the request of the city officials the Union Station Company agreed to build a utility gallery in Canal Street from Madison Street to Monroe Street, with a spur extending 80 ft. farther south in Canal Street to connect with possible future galleries in that thoroughfare, and in Monroe Street from Canal Street to Clinton Street. The City Council then appropriated $12,000 to carry the gallery one block farther north in Canal Street from Madison Street to Washington Street. The station company, by the terms



PLAN, LONGITUDINAL SECTION AND TRANSVERSE SECTION OF CHICAGO'S NEW UTILITY GALLERY IN CANAL STREET of its grant from the city, is obliged to maintain for ten years the pavements about the structures it is to erect. For further details as to the preliminaries see the editorial in the Engineering Record of Oct. 30, page 528.

CONCRETING AMID CONGESTED TRAFFIC

As the north end of the gallery on Canal Street parallels the east side of the Chicago & North Western station, with its enormous suburban traffic, an arrangement for furnishing concrete without blocking traffic had to be devised. A small triangular vacant lot lies to the east of the street. Alongside of it are the depressed tracks of the Chicago, Milwaukee & St. Paul Railway, over whose lines gravel, sand and bulk cement are furnished to the contractor.

The above factors led the contractor to erect a tower, and to chute the concrete directly across the street to a small bin, from which it is spouted to two-wheel buggies. A clamshell bucket lifts sand and gravel from the railroad cars to near-by storage piles, whence the same bucket delivers the material to the bins over the mixer. Bulk cement is delivered by a worm conveyor direct from the railroad cars to a cement bin also over the mixer. As the contractor also has a contract to build a large concrete retaining wall and a reinforced-concrete sewer on Canal Street, he will use the same concrete outfit for doing all three jobs.

FIND WOODEN STREET BURIED 8 FEET

In the excavation for the gallery an old gravel road was unearthed 6 ft. below grade, 2 ft. below that a 2-in. plank pavement in excellent condition was found, and about 11 ft. down the floor of an old-sub-sidewalk was revealed. In addition the brick foundation walls of former buildings, curb walls and the conduits and cables for water, gas, sewer, electric light, telephone and telegraph were found running in every direction. Under the sidewalk at the east entrance of the North Western station a concrete wall 2 ft. thick, inclosing a lavatory, was encountered and had to be torn out.

The gallery, a reinforced-concrete box of 6 x 8-ft. interior dimensions, with sides 10 in. thick, is being placed under the sidewalks. The top conforms to the slope of the present sidewalk, provision being made for a 4-ft. extension of the present sidewalk. The floor is sloped 1 in. to the center for drainage purposes.

CHANGE ORIGINAL PLANS

As the Chicago Telephone Company wanted separate manholes at Madison Street for its wires, the original plans were changed. As may be noted in the accompanying plan, the telephone company can pull their cables from either Madison or Canal Street as necessity demands. There are 19,000 telephone wires going through the gallery. Separate manholes are provided for the high and low tension wires.

Tunneling under the street railway tracks on Madison Street is now under way, the usual shoring methods and box heading being employed. Owing to the hazards and unforeseen difficulties to be encountered, the contractor, the W. J. Newman Company, Chicago, has been awarded the contract on a percentage basis for the portion of the gallery between curb lines on Madison Street.

C. C. Saner is the assistant engineer for the city in charge of construction, reporting to H. S. Baker, assistant city engineer, under whose direction the project was designed and fostered. John Ericson is city engineer, in charge of all work of the Bureau of Engineering.

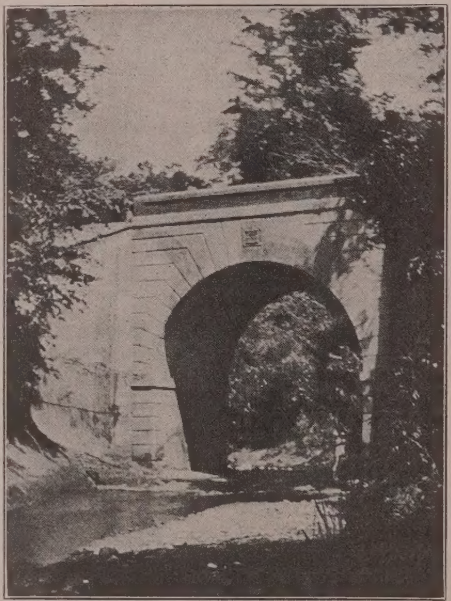
Specialized Experience of Engineers and Contractors Vital to Country's Defense

Can Be Made Available for Present Work and Future Need by Military Camps to Construct Defenses and Transportation Lines—Large Firms Should Take Lead

By GEORGE PERRINE

First Lieutenant First Regiment U. S. Volunteer Engineers, Spanish-American War; Assistant Tunnel Engineer, Rapid Transit Subway Construction Company, New York

THE PROFESSION of engineering and the business of contracting train men in the very essentials needed to carry on the modern operations of war. While the country is talking of preparedness, and while all realize that the immunity from attack by a powerful enemy which we have enjoyed so long may end at any time, what have engineers and those who have had experience in contracting done to place their organized services at the disposal of the country for emergencies, and what can they do?



PORTO RICAN BRIDGE BUILT BY VOLUNTEER ENGINEERS IN SPANISH WAR

In the first place, modern war is made possible largely by the engineer. It is impossible without adequate transportation, without adequate earthworks, without tools and materials of the latest design. In the second place, the maintenance of an army in the field is the same problem, on a scale commensurate with the size of the army, as that faced every day on every contract job in getting the men, the materials and the work together to produce results. The services which the engineer and the contracting man can render in defense of their country are thus performed behind the firing line and largely before the country is attacked. Therefore, there is immediate need of coöperation in this direction. No one need hang back from distaste of life in the trenches, as the services for which we are fitted are not performed with a rifle. No one need hang back waiting to enlist in the fighting branches of the army, as the service he can perform along the lines of his life training are as essential as those of the soldier, while there will be ten volunteers for the daredevil work to one who can capably handle the equally important business along the lines of communication.

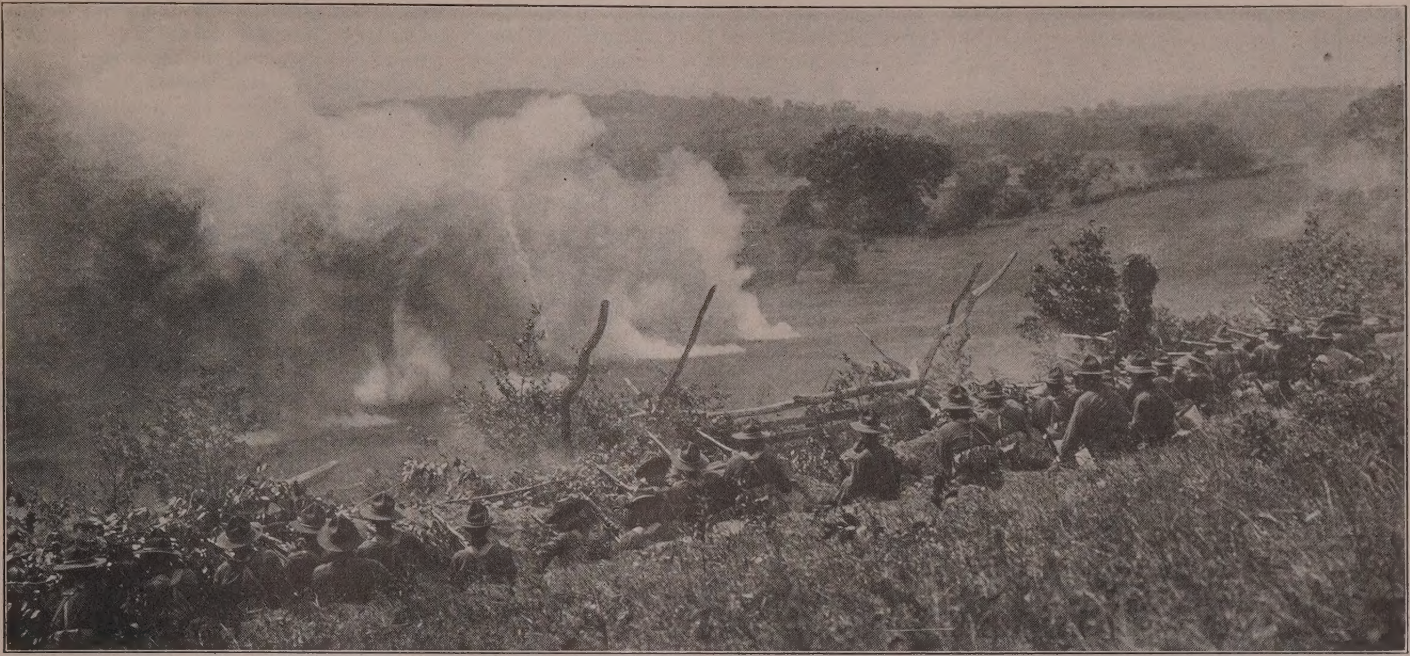
PREPARATION FOR DEFENSE

The first consideration for the defense of our extensive coast, it seems to the writer, is adequate coastal railroads and highways, out of reach of interference from a hostile fleet. Back of these, at suitable distances inland and apart, must be concentration depots for men and supplies, from which, over radial lines to the coastal roads, a threatened invasion could be opposed in force on short notice. These should have lines connecting with the interior supply centers of the country. The elements of such a system exist already. It could be perfected, and the missing links supplied most economically at Government expense, if large numbers of engineers and construction men would join military camps for a short period each year, where the time of the men would be devoted largely to surveying, grading and possibly completing the necessary stretches of railroads and highways. In the case of the railroads, if there were no prospects of immediate use for commercial purposes, the ties and rails would never have to be laid until the emergency called for it. This work could be done under pressure in a few days, if war were to be declared. The highways would be immediately available, and the Federal help in building them would be most valuable to the local population.

Modern steel and concrete forts have hopelessly failed in the present great war. Massive defensive earthworks, which in future will take their place, could be economically designed and constructed without elaborate outlay for working plants, by volunteer service of the sort outlined here. Guns to equip these works could be held in reserve at concentration centers. An early example of citizen service of this kind was afforded in Revolutionary times, when students of Columbia College turned out in force and helped build a fort still standing on Governor's Island in New York Harbor.

RESERVE READY IN PRACTICE

Under this plan men who have made, in the course of their daily business, a life study of maintaining and providing camps, of mobilizing and transporting men and equipment—men whose living has been made by having things "at the front" when they were needed—would be at the instant disposal of the War Department in emergencies. Equally important, men who could design and build emergency defensive works, bridges and lines of transportation



MINE DEFENDING TRENCH SPRUNG DURING MANEUVERS AT FISHKILL, N. Y.—CONTRACTORS' MEN COULD DO SUCH WORK WELL

would be available. Also, and by no means least important, an army of mechanics, carpenters, foremen, experts in handling explosives, riggers, stationary engineers, blacksmiths, cooks, teamsters and specialized workmen of all kinds, without whom no defense of any sort could be made against an invasion, would be available.

The great consideration is that no expensive training for these men is needed. It is not even essential that all should be able to drill or shoot. All that is required is for the Government to know who and where they are, and for them to know what they are to do and where they should report.

EXAMPLE IN PORTO RICO

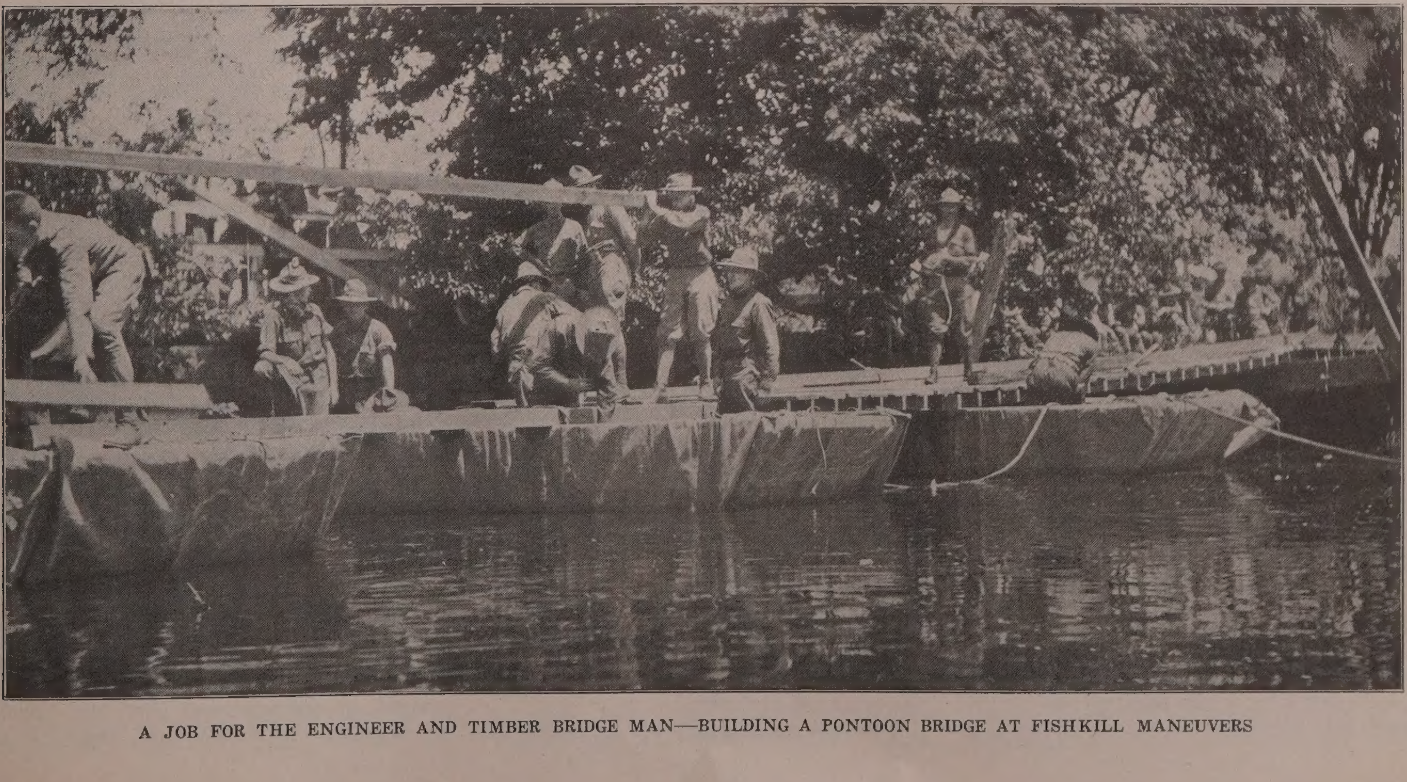
An evidence of this sort of service was brought out on a small scale in the American occupation of Porto Rico, where a volunteer engineer regiment of which the writer was a member supplied men on short notice to the regular army officers for erecting the hospital encampment, building a garbage incinerator, erecting an ice machine, rebuilding bridges and roads destroyed by the Spanish, handling supplies and doing other work of the thousand varieties that requires a specialist.

WORK FOR INDUSTRIAL ENGINEERS

The value of the services of engineers and others engaged in factories and industrial lines would also be great in a crisis. These men should know what their plants will be expected to supply in case of war, and plans should be made ready for converting them to the necessary use. The mechanics and workmen of each plant could be trained to make the changes, and the engineers and owners of the plant could be prepared to do their part in directing the work and arranging to have ready the extra equipment and supplies needed.

IMPORTANCE OF FOREMAN

Good foremen are needed in large military operations for a countless variety of services in constructing defenses and communications and in handling supplies. It would be folly in an emergency to take up the time of our few thousand army officers, who are the only men in the country with real military training, with such work. Good foremen, all the way from "pushers" to men who handle million-dollar construction contracts, have been trained to this work and could be made available by thousands. The men who served short periods each year in semi-military, semi-construction camps of the type proposed would have ready what simple personal equipment they needed, and could come to the aid of their

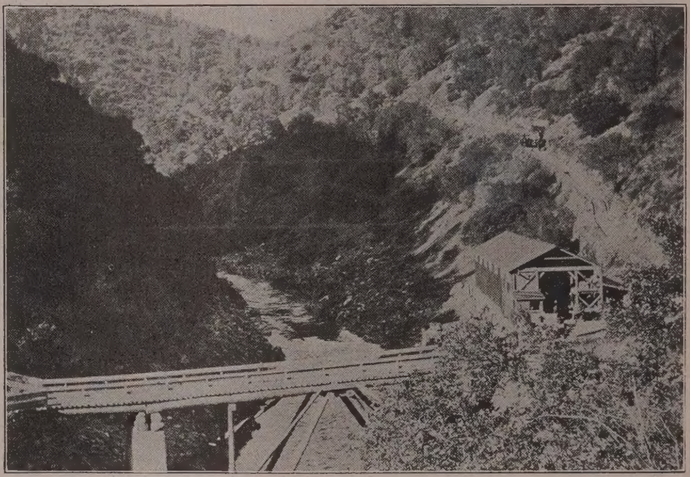


A JOB FOR THE ENGINEER AND TIMBER BRIDGE MAN—BUILDING A PONTOON BRIDGE AT FISHKILL MANEUVERS country in a crisis at a moment's notice and without confusion—a thing now impossible.

Big Firms Should Help

Contractors and engineers are at least as vitally interested in defending this country from imposition and attack which would cut their business short as is the Pennsylvania Railroad, which has announced that it will give vacations of sufficient length to all its employees who will take military training. Cannot the large contracting and engineering firms take the lead in offering vacations to all of their employees who will volunteer for a short period of military construction service of the kind outlined? Many of them would be in a position to lend the Government idle equipment at times for the use of such encampments, the Government to pay transportation and upkeep. It is high time that the engineers and contractors of this country did something definite to make possible a vital service in emergency to their country for which it can look to no other class of citizens.

NO ONE IS BETTER FITTED TO HANDLE SUPPLIES THAN THE MAN WITH CONSTRUCTION TRAINING



MEN WHO BUILT THIS BRIDGE IN ROCKIES TO CARRY MACHINERY COULD BUILD OTHERS TO CARRY BIG GUNS

New System of Filing Building Plans Saves Time

New York City Department Indexes Plans According to Lot Location—Colored Labels and Charge Cards Used

THE IMPROVED system of filing plans now used by the New York City Bureau of Buildings not only saves time and avoids confusion and delay for reference purposes, but minimizes the probability of errors by the use of colored labels, and insures an exact record of the location of plans by the method of numbering and the use of charge cards which indicate date taken out, person to whom charged and date returned. The number of filing clerks can be reduced as a result of the greater simplicity and rapidity of use of the new system, according to the last report of the bureau, from which the following abstract is taken.

Old System Caused Delay

The bureau has in its files at the present time more than a quarter of a million plans and applications for new buildings and alterations. The system of filing these in use since 1868 had become obsolete and absolutely inadequate for present needs, because of the length of time lost locating plans in the confused and congested plan room. The method of filing in the past had been to give each plan a serial number, together with the year number, and file it away in bins containing from 25 to 100 plans of all sizes. To locate any plan it was necessary to take out all the plans in any one compartment and turn each one to read the number on the side.

The borough of Manhattan is divided into eight tax sections. The blocks in each section have been given definite numbers, and likewise the lots in each block have also been given definite numbers. These block and lot numbers remain constant, thus furnishing an ideal basis for a system of numbering and filing plans. The new system consists in indexing the plans according to the location of the premises on which the building is to be or has been built, that is, giving the plans the numbers of the lot and block, and filing them away in geographical order according to locations of the lots and blocks upon which the buildings stand.

Labels with Location Numbers

All the plans are to be rolled on sticks of uniform length and stored in cases of uniform depth, thus preventing any small plans from being lost or two plans being rolled together and lost, as frequently happened under the old system. On the end of each stick is a label containing the number of the plan, so that the plan numbers can be read without removing them from the compartments.

To insure the filing of the plans in their proper location, the plans for each block are given a separate and distinct color from those in adjacent blocks. The color appears in the label at the end of each stick holding a plan. Further, in order to show the general position of the plan, the plans in each tax section are given a distinctive color on the neck of the stick back of the label. It can be readily seen from this color scheme that it will be impossible for a plan to be lost in the files, for a casual inspection of the plan files will detect any misplaced plans by means of the fact that the color in the label does not correspond with the others in the same compartment.

Constant applications are being received from other departments to consult these old plans; for instance, along the lines of the projected subway all the plans for buildings are desired in order to determine the nature of the foundations of the buildings that are to be preserved during the subway excavation. All these plans under the new system of filing will be in adjacent compartments and can be instantly found when wanted. Likewise, architects and owners are continually calling for these plans whenever they desire to make alterations to existing buildings. This new system will be a great help to them, because of the fact that all the plans covering building operations in any one site can be instantly found.

At the present time the plan files contain thousands of plans for buildings that have been demolished to make place for new buildings erected upon their sites. The new system of filing will automatically remove these from the plan files, for when a new building plan is filed upon any lot, the new plan will take the geographical position which the former plan occupied in the plan room.

Charging and Checking

A new charging and checking system for keeping track of the plans and applications in the bureau has been instituted during the past year. This consists in adapting the system in use in the loan department of the New York Public Library, namely, a charge card is placed in each application and when an application leaves the plan desk it is noted on this card to whom it is charged, with the date, and when the application is returned the date is also noted. The plan clerk under this arrangement will have either the application in the files or a card at the charging desk whereby he can tell instantly the location of the plan.

Every property owner in the borough will know the building-bureau plan number of his property, for this number will be the lot and block number which always appear on his tax bill, thus placing the records of the bureau immediately at his disposal.

REMOVING 258,000 TONS OF SEDIMENT from the water of St. Louis in 1914 cost 22½ cents per inhabitant. In the classification process, which was used prior to the construction of the filters, 13,660 tons of lime and 6770 tons of sulphate of iron were applied to 34,656 million gallons of water. E. E. Wall in his annual report pictures it for the layman as follows: "Had it been loaded on ordinary coal cars, they would have made a train 112 miles long."

Building-Area, Height and Other Limitations to Use of Private City Property Compiled

Data Presented by Nelson P. Lewis in Engineering Congress Paper on City Planning Show Practices in American and European Cities

MUCH of the paper on city planning presented by Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, at the recent International Engineering Congress was published in the Engineering Record of Sept. 25, page 382, and that of Oct. 2, page 415. The paper discussed other phases of the general subject than those published in the issues referred to, however. There was, for example, considerable statistical information relative to building-area and height and other limitations to private property. These statistics are abstracted as follows:

AREA LIMITATIONS—EUROPEAN CITIES

The following are area limitations in various foreign and American cities:

Berlin, Germany.—The lot is divided into three theoretical zones, the first being 6 m. wide from the building line, the second 26 m. wide and the third embracing all the remaining land. All of the first zone may be occupied, 7/10 of the second, and 6/10 or 5/10 of the third, depending on whether it is inside or outside the former city walls. When the allowable building area is computed by this means, however, the building may occupy that area in the whole lot irrespective of the zones.

Düsseldorf.—The city is divided into five zones for which the heights of buildings are fixed, and in each zone there are from two to five classes prescribing the proportion of a lot which may be built upon. The proportions vary from 3/10 to ¾.

Leipzig.—The rear courtyard must be as wide as the height of the rear wall of the building.

Birmingham, England.—Behind all new dwellings there must be an aggregate unoccupied area of not less than 300 sq. ft.

Sheffield.—Behind all dwellings there must be unoccupied areas aggregating not less than 150 sq. ft. for buildings 15 ft. high, 200 sq. ft. for those 25 ft. high, 250 sq. ft. for those 35 ft. high, and 300 sq. ft. for those more than 35 ft. high, the height in all cases being measured to a point halfway up the main roof.

AMERICAN CITIES

New York.—Dwelling houses accommodating not more than two families may cover 90 per cent of the lot; hotels may occupy 90 per cent of interior and 95 per cent of corner lots above the second floor, but for each and every story above five an additional 2½ per cent of the lot area must be left free. In the case of lodging houses 35 per cent of interior and 8 per cent of corner lots must be left open. Office buildings on interior lots may cover 90 per cent of the lot at and above the second floor, while those occupying corner lots having an area of 3000 sq. ft. or less may cover the entire lot. Tenement houses, or those accommodating three or more families, may cover 90 per cent of corner lots having areas not more than 3000 sq. ft., but if located on interior lots more than 90 ft. but not exceeding 105 ft. in depth, 30 per cent of the lot area must remain uncovered.

Chicago.—Tenement houses must not be built nearer than 10 ft. to the rear lot line, except that when the lot abuts on a public alley the rear line of the building may be within 16 ft. of the opposite side of the alley. Rear buildings may be erected on a lot only on condition that the minimum distance between front and rear buildings is 10 ft., to which 5 ft. must be added for each story more than one of the higher building on the lot; provided that a one-story building without basement and not used for habitation may be placed on the rear of a lot containing a tenement house if a minimum distance of 10 ft. between buildings is maintained at every point.

Philadelphia.—No building for dwelling purposes shall have a frontage of less than 14 ft. At least 144 sq. ft. of the lot must be left open.

Boston.—Where tenement houses have no open space on either side they must have a yard the full width of the building at least 12 ft. deep in the rear, and the building must not exceed 1800 sq. ft. in area.

HEIGHTS OF BUILDINGS—EUROPEAN CITIES

The following are limiting heights of buildings in various cities:

Berlin.—Building heights are limited to the width of the streets upon which they front, measured between building lines. The fronts of no buildings for habitation may exceed five stories in height, although the roof may be carried to a greater height, provided no part of it projects beyond a line drawn at an angle of 45 deg. back from the top of the front wall. In the case of rear buildings or buildings fronting upon inside courts the limits of height are governed by the dimensions of the court, but their height may not exceed by more than 6 m. the width of the court on which they front, and in no case may it exceed 22 m.

Düsseldorf.—Of the five zones already referred to, the limiting heights are respectively 20 m.; 16 m., or, where four stories are allowed, 20 m.; the same; 16 m.; and 13 m., or, where three stories are allowed, 16 m. In none of the zones, however, may the height of the buildings exceed the width of the street upon which they abut. The classes of buildings which govern the proportion of the lot area which may be built upon varies in each zone.

Leipzig.—The height of buildings to the top of the main cornice may not exceed the width of the street, while in the central part of the city this height may not in any case exceed 22 m.

Birmingham.—No building shall exceed 100 ft. in height.

Sheffield.—New buildings are limited in height to the width of the street upon which they front, although provision appears to be made for carrying them to a greater height by special permission.

Liverpool.—Dwelling houses erected in new streets are limited in height to the width between opposite buildings, but there is no limit to the height to which business buildings may be carried.

AMERICAN CITIES

New York.—The labor, tenement house and other special laws impose a virtual limit upon the height of certain classes of buildings, but there is no direct limit prescribed by statute or ordinance, except that which restricts buildings used as dwellings to a height of 1½ times the width of widest abutting street. Office buildings may be carried to any height.

Chicago.—Tenements or dwelling houses may not exceed by more than one-half the width of the widest street on which they front—buildings set back from the street line being allowed to add the amount of such set back to the street width in computing the allowable height. Fireproof buildings for office and business purposes may be carried to a height of 200 ft. above the sidewalk level, but prior to Sept. 1, 1911, the maximum height for such buildings was 260 ft.

Philadelphia.—No law or ordinance limiting building heights.

Boston.—Buildings in the business section may not exceed 2½ times the street width, and in no case may be more than 125 ft. high. In other parts of the city the limit of height is 80 ft., except that where but one side of the street is built upon or where its street is 80 ft. or more in width, the height may be 100 ft. Wooden dwellings are limited to three stories above the basements, but may in no case be more than 45 ft. above the street level.

Washington.—On Pennsylvania Avenue 160 ft. is the limiting height; on other business streets 20 ft. more than the street widths, with a flat limit of 130 ft.; on residential streets, 85 ft., provided that on streets over 70 ft. wide the height may not exceed the street width minus 10 ft.; on streets from 60 to 70 ft. wide, 60 ft., and on streets less than 60 ft. wide, the street width.

Charleston, New Orleans, Cleveland and Fort Wayne.—Building heights are restricted to 2½ times the width of the widest street, with absolute limits in the four cities of 125, 160, 200 and 200 ft. respectively.

Buffalo and Rochester.—Height is limited to four times the average least dimension of the building, without specific limit in feet.

Toronto.—Height of five times the least dimension, with an absolute limit of 130 ft.

RESTRICTIONS AS TO USE

A further and more radical step in the direction of restricting the use of property outside the street line is the attempt to specify the uses to which the property may be put. While for many years the conduct of noxious trades or occupations has been quite generally prohibited within city limits or restricted to certain districts, the division of the entire city into districts, in each of which is prescribed the use to which private property may be put, is now claimed to be a reasonable exercise in the authority of the municipality. This plan of districting has been most fully developed in the German cities. The factory districts are naturally located along the lines of rail or water transportation, but their position with respect to the remainder of the city is often determined by the direction of prevailing wind.

Following are regulations of this character adopted in America:

Los Angeles.—The entire city, except two suburbs, is divided into industrial and residential districts, there being twenty-five of the former and only one of the latter. The former are widely scattered and the latter includes the remaining area, so that it entirely surrounds many of the industrial districts and really covers the entire city. Within the residential district are fifty-eight districts designated as "residential exceptions," in which business is permitted subject to certain conditions. One of these is about ½ sq. mile; the others are small, covering not more than two city blocks. The restrictions are not sweeping. The largest industrial district has an area of several square miles; the smallest consists of a single lot. Their combined area is only about 1/10 that of the residential district. In most of them all kinds of business and manufacturing are unrestricted, while certain specific kinds of business are excluded from the residential district, but those not specially excluded are permitted in the "residential exceptions," although the owners of 60 per cent of the neighboring property fronting must consent to the establishment of any "residential exception."

Seattle.—Use to which property may be put is restricted.

Baltimore.—Use of property in certain sections is regulated.

New York State.—The municipal legislative body in any city of the second class, on petition of two-thirds of the property owners affected, may establish residential districts within which no building other than single or two-family dwellings may be erected, such restrictions to continue until a similar petition shall have been presented to and approved by the same body.

Massachusetts.—Any city or town in the State except Boston, which is governed by special act, may regulate the height, area, location and use of buildings and other structures for the prevention of fire and the preservation of life, health and morals, except, however, bridges, quays, wharves and structures owned and occupied by the National or State Government.

Minnesota.—Minneapolis, St. Paul and Duluth may by two-thirds vote of the municipal legislative bodies when petitioned to by a majority of property owners in any proposed district establish residential and industrial districts. Authority is given to classify the various industries and restrict each class to a definite limited area, while upon a similar majority petition the original restriction may be set aside. Minneapolis has created certain industrial and residential districts.

Wisconsin.—Similar powers have been conferred on eight of the principal cities of the State.

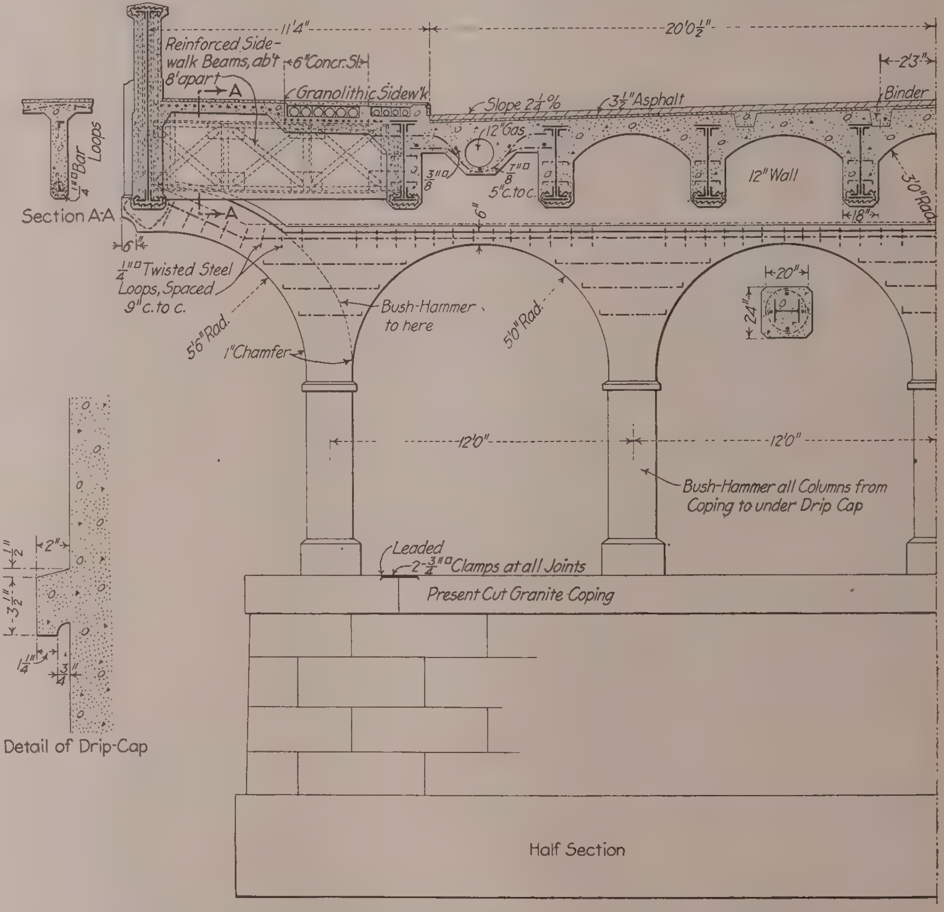
Ontario, Canada.—The Provincial Legislature has authorized the councils of cities of more than 100,000 inhabitants to restrict the erection of buildings of certain classes to designated parts of the city. Toronto has acted under the provisions of this law, and apartment houses and garages are excluded from most of the residential streets.

IN REPAIRING STREETS where trenches have been cut in concrete foundations the city of Detroit requires that all concrete used in repairing shall be at least 8 in. thick and shall extend in every direction beyond the edge of the excavation a distance of 6 in. at the bottom of the concrete and 8 in. at the top. The object of this provision, states the commissioner of public works, is to secure a shoulder of solid earth for the new concrete to rest upon, with the object of preventing settlements which have heretofore invariably occurred.

Street Bridges in Philadelphia Designed for Permanent Artistic Effects

Highway Crossings Over Railroads Kept Clear of Obstructing Girders —Steel Protected by Concrete with Effective Surface Treatment

RECENT BRIDGES just completed or in process of design or construction under the supervision of the Bureau of Surveys of the City of Philadelphia contain certain basic features of artistic and effective treatment which are worthy of record. The principal features of several small spans of various types will be described—a 28-ft. arch span on weak foundations in which the arch thrust is resisted by reinforced-concrete ties below the springing line, a street crossing over a railroad, showing typical steel and concrete construction for unobstructed roadway and sidewalks, including arched concrete column incasement to improve the appearance from the car windows, and the architectural treatment of steel undergrade bridges by the use of concrete pylons, artistic railings and abutments, sodded slopes, and the painting of steel to harmonize with the substructure.



ARCHED CONCRETE COVERING FOR COLUMNS, SEVENTY-FIRST STREET BRIDGE

GENERAL SPECIFICATIONS AND LOADING

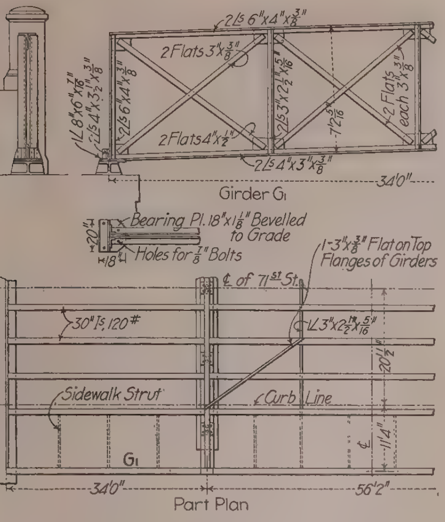
Street bridges in Philadelphia are subject to the specifications and approval of the Bureau of Surveys. The specifications drawn up by the Bridge Division contain the following requirements and recommendations regarding general design:

"When conditions such as span, headroom, foundations and facility of erection permit, a concrete-arch type of bridge is preferred, and if sufficient rise can be obtained the arch shall be of rubble concrete without steel reinforcement. The limit of flatness permissible without reinforcement is the curvature of a radius equal to the span. Steelwork over railroads shall be incased in concrete with a minimum thickness of covering of 3 in. For highways deck bridges are always preferred, no girders or trusses being permitted to project above the floor surface of either driveway or sidewalks except as parapets, unless limited depth of floor or other circumstances make the preferred construction impracticable or unreasonably expensive. Columns in sidewalks and recesses in abutments are objectionable and to be avoided whenever practicable."

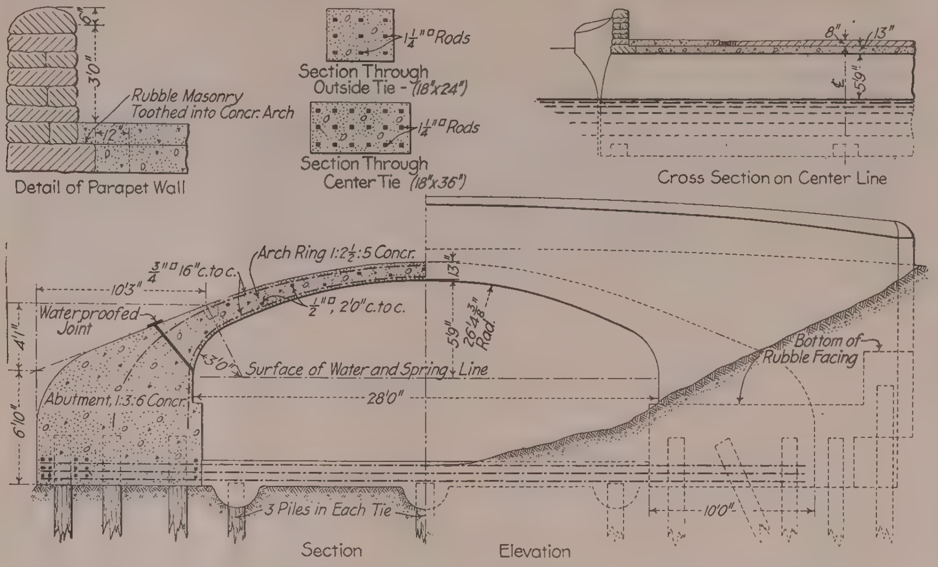
The specified live load is as follows:

(a) A uniformly distributed load over the entire surface, including driveway and sidewalk (or the entire surface of foot-bridges) of 100 lb. per square foot for spans up to 75 ft. Sidewalk brackets, joists and floor to be proportioned for a local loading of 110 lb. per square foot. For main girders or trusses of bridges with cartway less than 34 ft., add 600 lb. per linear foot of bridge for additional general load on one street-railway track, and for bridges with cartway 34 ft. or over add 1200 lb. per linear foot of bridge for additional general load on two street railway tracks.

(b) A concentrated moving load of 20 tons on one axle with wheels 5 ft. apart on any part of the driveway; or 27 tons on



SEVENTY-FIRST STREET BRIDGE DETAILS



TYPICAL SMALL ARCH BRIDGE DETAILS—28-FOOT SPAN IN LEAGUE ISLAND PARK

two axles 7 ft. apart on each street-railway track; or 40 tons on two trucks 20 ft. center to center, with axles 5 ft. center to center on each street-railway track. Stresses produced by the street-railway concentrated loads are to be increased for impact by the formula

$$P = 5/(L + 5)$$

where P is the added percentage and L is the loaded length of the bridge producing the maximum stress in the member.

The unit stresses for steel and concrete are in accordance with usual standard practice. Of the concrete protection for girders the part in compression is considered to carry its proportion of the stress.

ARCHES WITH TIES BELOW THE STREAM

A series of five small arches varying in span from 24 to 40 ft. carrying park drives over lagoons in League Island Park are now being constructed. The foundations are soft and require the use of piles, but rather than depend on the thrust resistance of battered piles, it was decided to use reinforced-concrete ties below the stream and design the abutments as horizontal beams. One of the accompanying drawings gives typical details and shows the three ties used and the manner of bending the rods to act as shear bars in the abutments.

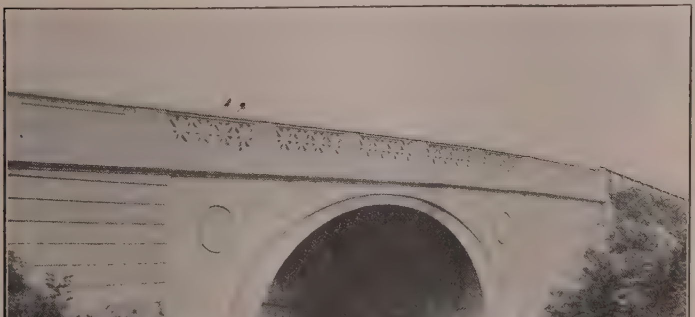
Although not drawn in detail on the elevation, the facing and parapet walls are being built of rubble stone from Conshohocken, of the general dimensions shown on the section. This parapet wall is used as the facing form for the concrete of the main arch, and gives the appearance of stone arch construction. The sweeping curves of the design work out better in rubble than would be possible in concrete except at very much increased expense for forms and workmanship.

TYPICAL STREET CROSSING OVER RAILROAD

The recently completed overhead crossing at Seventy-first Street over the Philadelphia, Baltimore & Washington Railroad is a fair example of the construction used to preserve an unobstructed roadway and sidewalk, and also furnish a structure of satisfactory appearance by covering and preserving the steel with concrete. The accompanying drawings and photographs show the typical details and appearance of this structure. Shallow intermediate plate girders with cover plates are used in the longitudinal direction spanning four tracks with plain concrete jack arches between them. The deep outside (railing) trusses are composed of four angles laced with double flats for diagonals in both directions and vertical posts, as shown by the detail of the end of the 34-ft. truss shown. The sidewalk struts are built up of two angles double-laced with 3 x 5/16-in. flats and single angles vertical. Concrete covers the steel as required to a minimum depth of at least 3 in.

The intermediate columns are of 12 in. H-section with standard details. They support the main cross girders, which are 3 ft. 9¾ in. out to out, masked and protected by the concrete in arched form as shown by the half cross-section. The old masonry piers, built fifteen years ago with a view to supporting a steel bridge with wood floor were used, the existing coping stones being anchored together by clamps, as noted, in order to resist any possible spreading from the fact that the outside columns are the most heavily loaded.

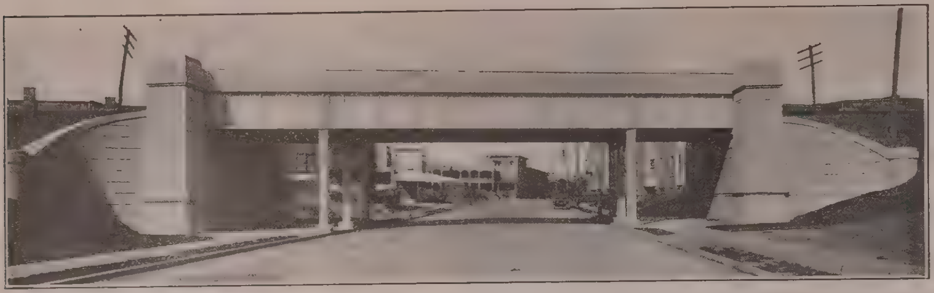
Other details of the floor construction are noted on the section. Attention is called to the method of providing for the 12-in. gas main and reinforcing the concrete for the panel in which it occurs, also the provision for future trolley rails. The facing concrete on exposed surfaces was finished by bush-hammering. The columns up to the drip cap were so finished because easily visible from the windows of passenger trains. This drip cap is shown in detail, and makes an effective springing line for the arched concrete in addition to the protection for the finished surface below. The use of drip caps under the bridge deck is justified by the amount of dirty con-



LUZERNE STREET ARCH BRIDGE WITH EFFECTIVE RAILING

SEVENTY-FIRST STREET BRIDGE OVER P. B. & W. RAILROAD

Steel columns shown in right-hand picture are masked in arched concrete.



DOUBLE-TRACK RAILROAD BRIDGE OVER FIFTY-FIFTH STREET

Ornamental pylons and curved wing walls with bush-hammered facing—steel painted to harmonize in color—slopes of embankments sodded

densed steam which accumulates on the concrete overhead.

ARCHITECTURAL EFFECTS

Other examples of the results being obtained in the effort to apply simple but effective modifications in outlines for ornamentation are indicated by the photographs of the Fifty-fifth Street Bridge under the Philadelphia & Baltimore Central Railroad and the Luzerne Street crossing over the Pennsylvania Railroad, Oxford Road Branch. The Fifty-fifth Street Bridge is a double-track structure on a curve and spans an 80-ft. street. It was, therefore, necessary to allow the use of curb columns in order to reduce the girder depth. The striking features in the ornamental treatment of this structure are secured by the heavy pylons hiding the ends of the girders, the curved wing walls with effective cylindrical ends, the bush-hammered facing of Port Deposit granite chips, the painting of the steelwork to harmonize with the concrete, and the sodded slopes which furnish a contrasting green outline for the wing walls.

The 37-ft. arch bridge carrying Luzerne Street over the Oxford Road Branch of the Pennsylvania Railroad is improved in appearance by the panel outline of the arch, the circular panel ornamentation, the false horizontal joints (also used in the Fifty-fifth Street bridge) and the effective design of the concrete railing. This form of railing is one of the best used in these city bridges, and was described in detail in the Engineering Record of Oct. 11, 1913, page 401, in an article describing other ornamental bridges in Philadelphia. It was cast on the ground in units one panel in length instead of being poured in place, and expansion joints were provided in its erection.

SURFACE TREATMENT

It so happens that the concrete structures above mentioned have been surface-finished with the "bush-hammer"—the customary name for what is properly called the "patent," or parallel-bladed hammer. This is an alternative for the method of scrubbing the green concrete with brushes and water to reveal the aggregate. One method or the other is used on the exposed surfaces of all concrete built by or under the supervision of the Bureau of Surveys. The scrubbing method is found to require special framing of forms and extreme care in their removal; the bush-hammering method permits the forms to remain in place as may be desired and the finishing to be postponed until a convenient time. On the other hand, the hammering is apt to damage a design which contains many small features with sharp edges. The two methods are alternated as the nature of the design, situation and material seem to require, and the choice makes a negligible difference in the contract price.

This work is being done under the direction of George S. Webster, chief engineer of the Bureau of Surveys, Philadelphia. The details of design and construction are directly under the supervision of Jonathan Jones, assistant engineer, who kindly furnished the data here given.

How Curing at Low Temperatures Affects Concrete

A. B. McDaniel Reports Results of Tests—Compressive Strength of Concrete Cured at 60-70 Deg. Double That at 32-40 Deg.

OF SPECIAL economic importance to the contractor or the builder is a knowledge of the strength of concrete at early ages under different temperature conditions. Exact information will then replace guesswork as to when forms may be removed and what loads may be safely applied to the different parts of a concrete structure. Tests, therefore, were made at the laboratories of the University of Illinois during 1913 and 1914 and were recently reported by A. B. McDaniel, assistant professor of civil engineering at that institution, in Bulletin 81 of the Engineering Experiment Station.

Three groups of tests were made—group 1, forty-five 6 x 6-in. cylinders; group 2, fifty-one 6-in. cubes, and group 3, sixty 8 x 16-in. cylinders, subjected to various molding and storage temperatures. All test specimens were made with Universal Portland cement, clean, well graded Attica sand, and crushed limestone in the proportions of 1:2:4 by weight, or 1:2.2:3.6 by volume. The materials for each specimen were weighed out separately and then mixed. The temperature of the storage room was determined by daily readings of maximum and minimum thermometers. All the specimens while in storage were covered with several layers of moist sacking, which was sprinkled daily.

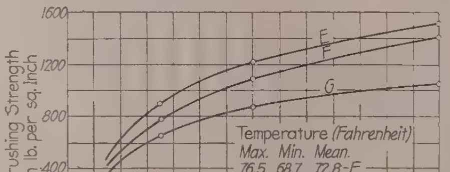


FIG. 1—STANDARDIZED VALUES FOR 6 X 6-IN. CYLINDERS OF GROUP 1

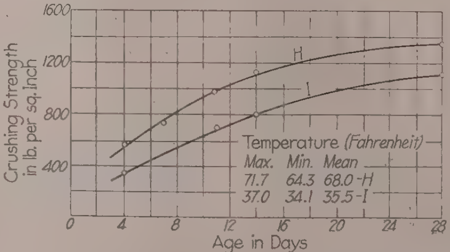


FIG. 2—STANDARDIZED VALUES FOR 6-IN. CUBES OF GROUP 2

The specimens of group 1 were tested in about 20 hr. after removal from storage at the given temperature. The specimens of groups 2 and 3 were brought to the laboratory and tested within 1 hr., with the exception of two specimens which were stored in a room varying in temperature, as mentioned below, and kept in the laboratory at 70 deg. Fahr. for 7 days and 21 days respectively before testing.

STANDARDIZED STRENGTH—EFFECT OF NON-UNIFORM TEMPERATURE

The observed values for the cubes and short cylinders of groups 1 and 2 have been reduced to the equivalent strength which would be obtained for standard cylinders of height equal to twice their diameter by multiplying by 0.73, the ratio determined by the committee on specifications of the American Concrete Institute. These equivalent average values are given in Figs. 1 and 2 for the temperatures indicated on the diagrams.

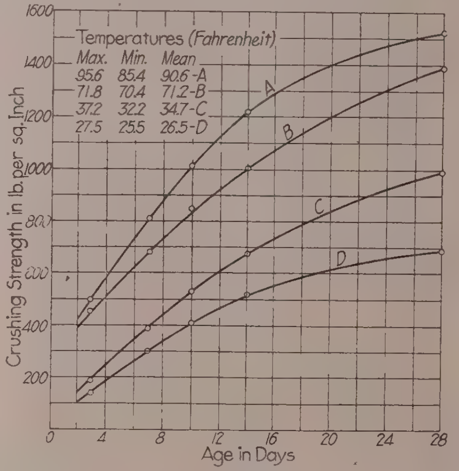


FIG. 3—AVERAGE VALUE FOR 8 X 16-IN. CYLINDERS OF GROUP 3

The specimens of one set were stored in a room where it was known that the temperature would not be uniform. The mean temperature varied from 22 to 35 deg., with an average of 27 deg. for 42 days. All of these specimens tested at 11 days were slightly disintegrated on the surface, and those tested at 28 days were badly disintegrated. Of those reserved to be tested at 42 days only one could be tested, the other two being very badly disintegrated. These two specimens were then kept in the laboratory, as described above, for 7 and 21 days respectively. The 42-day specimen failed at 420 lb. per square inch, while the 49-day specimen (5 x 5 x 6 in.) failed at 1270 lb. per square inch and the 63-day specimen (4 x 5 x 6 in.) at only 400 lb. per square inch. These results indicate that the low temperature retarded the hardening action of the concrete, and that the alternations above and below freezing caused a softening and crumbling of the material.

The average results for the standard 8 x 16-in. cylinders at the mean temperatures shown are given in Fig. 3. It is noteworthy that under a temperature slightly below freezing the concrete gained strength continuously. It is also interesting to note that the curve for a mean temperature of 26.5 deg. is substantially of the same character as that for a mean temperature of 71.2 deg.

The tests are summarized in Figs. 4 and 5. Fig. 4 shows the relation between strength and temperature for the several ages of the tests, and Fig. 5, drawn from the values in Fig. 4, shows in a general way the relation in per cent between the strength at 28 days for a temperature of 70 deg. and the strength attained at various ages under varying temperatures. These values are sufficiently accurate to furnish suggestive information which may be useful in determining the time when forms may be removed and loads applied.

GENERAL CONCLUSIONS

It is believed the following general conclusions are justifiable:

1. Under uniform temperature conditions, there is an increase of strength with age within the limits of the tests. For any temperature the rate of increase decreases with the age of the specimen, and this rate of increase is less correspondingly at the lower temperature conditions. For the specimens tested, under normal hardening temperature conditions of from 60 to 70 deg. Fahr., the compressive strength of the concrete subjected to a uniform temperature at the ages of 7, 14 and 21 days may be taken as approximately 50, 75 and 90 per cent of the strength at 28 days, respectively. For lower temperatures the percentage values are less, and for higher temperatures the percentages are higher. The relation between the percentage values at the ages of 7, 14, 21 and 28 days is nearly the same for temperature conditions from 30 to 70 deg. However, the values for the lower temperatures should be used with caution.

2. Concrete which is maintained at a temperature of from 60 to 70 deg. will, at the age of one week, have practically double the strength of the same material which is kept at a temperature of from 32 to 40 deg.

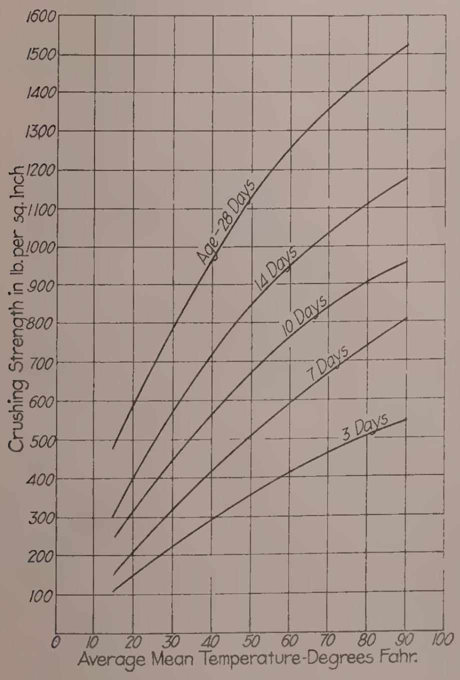


FIG. 4—RELATION OF STRENGTH TO TEMPERATURE AT DIFFERENT AGES

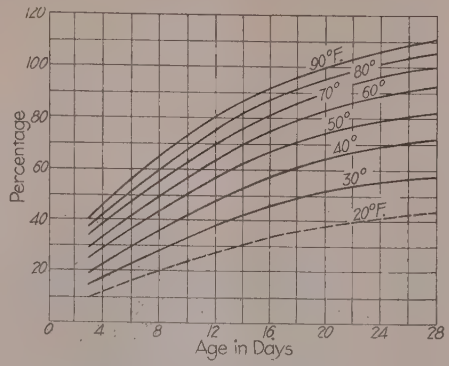


FIG. 5—STRENGTH PERCENTAGES FOR VARIOUS MEAN TEMPERATURES

Percentages are based upon strength at 70 deg. for 28 days.

3. Figs. 4 and 5 may be used to determine the representative strength of concrete similar to that used in these tests, for various temperature conditions and for ages up to 28 days. These diagrams may be used with a fair degree of approximation to ascertain the relative strengths which concrete of ordinary practice may be expected to attain at the different temperatures.

It should be noted that generally in this investigation the specimens were stored under temperatures which were nearly uniform during the whole storage period. In one set the variations in temperature include a number of alternations above and below the freezing point, and the specimens were seriously injured. The results accord with the well known effect of freezing and thawing upon green concrete.

The tests were made under the supervision of Professor McDaniel—those of groups 1 and 2 by J. A. Anderson and W. J. Bublitz, and those of group 3 by J. A. Anderson.

Mileage of Government Valuation Inventory Tabulated

THE MILEAGES covered up to Sept. 30, 1915, by the Government in connection with the field work of evaluating the railroads is given in the accompanying table, taken from a progress bulletin issued by Thomas W. Hulme, general secretary of the Presidents' Conference Committee. It will be noted that on three good-sized roads—the Kansas City Southern, the San Pedro, Los Angeles & Salt Lake and the Western Pacific—as well as on ten smaller lines the parties inventorying roadway and track have completed their tasks, while on larger systems, such as the Boston & Maine, the Chicago & Eastern Illinois, the Big Four, the Great Northern, the Rock Island and the Central of Georgia, the work is well advanced.

PROGRESS OF FIELD INSPECTION, SEPTEMBER 30, 1915, FOR GOVERNMENT VALUATION OF RAILROADS

Road	Date Division of Valuation forces began work	Miles of road	Total miles inspected and inventoried to date: Road and track	Bridges	Buildings	Signals	Telegraph and telephone	Total miles "Adjacent Similar Land" inspected
Eastern Group								
Boston & Maine	4–29–14	2,434	2,246	798	798	835	2,326	1,235
Chicago & Eastern Illinois	5–2–14	1,140	1,104	1,102	1,102	989	1,123	989
Cleveland, Cincinnati, Chicago & St. Louis	8–24–14	2,381	1,960	1,441	820	1,952	2,218	....
Pennsylvania	1–1–15	5,919	1,248	1,030	1,039	890	1,058	210
New York, New Haven & Hartford	3–31–15	2,046	553	....	....	....	....	108
Boston & Albany	4–21–15	392	159	106	....	....	....	....
Chicago, Indianapolis & Louisville	5–25–15	610	424	610	....	....	386	....
Ann Arbor	6–1–15	292	* 292	292	292	292	292	....
Maine Central	8–14–15	1,057	102	....	....	....	63	....
Bangor & Aroostook	8–16–15	626	106	....	....	....	....	....
Total	....	16,897	8,194	5,388	4,051	4,958	7,466	2,542
Western Group								
Texas Midland	....	111	* 111	111	111	111	111	111
New Orleans, Texas & Mexico	....	173	* 173	173	173	173	173	173
Kansas City Southern	....	878	* 878	878	878	878	878	878
San Pedro, Los Angeles & Salt Lake	....	994	* 994	994	994	994	994	994
Elgin, Joliet & Eastern	....	211	* 211	211	211	211	211	211
Western Pacific	....	981	* 981	981	981	981	981	981
Quincy Western	....	6	* 6	....	....	....	....	....
Missouri Southern	....	54	* 54	54	54	54	54	54
Mississippi River & Bonne Terre	....	54	* 54	54	54	54	54	54
Arizona & Swansea	....	21	* 21	....	....	....	....	....
United Verde & Pacific	....	26	* 26	....	....	....	....	....
Cape Girardeau Northern	....	106	* 106	106	106	106	106	....
Minneapolis, St. Paul & Sault Ste. Marie	5–1–14	4,125	2,109	404	404	404	....	500
Great Northern	5–3–14	7,321	4,597	1,927	1,927	3,504	6,495	592
Rock Island lines	8–1–14	7,680	5,711	1,667	1,667	720	7,210	....
Chicago & North Western	9–2–14	8,346	91	91	91	91	91	91
St. Louis Southwestern	11–12–14	1,568	747	747	747	....	747	747
Illinois Central	11–18–14	5,960	1,673	1,726	1,726	1,166	4,077	1,506
Santa Fe	12–4–14	11,117	1,109	1,109	1,109	....	2,107	....
Southern Pacific	1–3–15	6,906	248	....	....	561	705	....
Chicago, Milwaukee & St. Paul	5–22–15	9,611	1,271	....	....	....	....	498
Total	....	66,249	21,171	11,233	11,233	10,008	24,994	7,390
Southern Group								
Norfolk Southern	2–27–14	903	903	903	903	903	903	....
Atlanta, Birmingham & Atlantic	2–19–14	658	658	658	658	658	658	650
Central of Georgia	7–8–14	1,972	1,972	1,959	1,902	1,972	1,972	1,972
Savannah & Northwestern	2–18–15	109	109	109	109	....	109	....
Charleston & Western Carolina	5–29–15	341	341	None	None	None	297	....
Georgia Southern & Florida	1–2–15	605	605	605	605	605	605	....
Mobile & Ohio	6–15–15	1,114	600	None	None	None	None	....
Southern	7–14–15	7,000	275	None	None	None	None	....
Total	....	12,702	5,463	4,234	4,177	4,138	4,544	2,622
Grand total	....	95,848	34,828	20,855	19,461	19,104	37,004	12,554

*Field work of roadway and track parties completed.

TOWER AND CHUTES KEEP CONCRETE AHEAD OF REST OF WORK

Well-Designed Concrete Plant Aids Construction of Waterworks Dam

Spouting System Places Good Concrete on Development of Bridgeport Hydraulic Company—Aggregate Is Washed a Batch at a Time in Measuring Hopper

A WELL-DESIGNED concrete plant of greater capacity than would ordinarily be considered necessary for the job is materially aiding the economical construction of a small dam being built by the Bridgeport Hydraulic Company on the Means Brook watershed near Bridgeport, Conn.

This company supplies the city of Bridgeport with about three times the quantity of water consumed by other cities of its size, on account of the large manufacturing interests located there. This business is growing very rapidly, and makes profitable the development of the smaller watersheds in the vicinity, of which the Means Brook watershed is one. A 36-in. pipe line will conduct water from the dam to the main storage basin, whose level is to be raised 10 ft. to accommodate the supply from this and other developments. The Hemlocks dam, another unit of this company's system, which was described in the Engineering Record of Sept. 14, 1912, page 392, has recently been put in service.

CONSTRUCTION PROBLEMS

The dam is of concrete, on a foundation of gneiss, and extends across the creek valley from east to west. Only 12,000 cu. yd. of concrete are required, and the greater part of the time necessary to complete the job is taken up in excavating the rock to secure a sound foundation. As the job is several miles from the nearest railroad or town, necessitating a camp for the men, and as the supply of good labor was not found plentiful, only so large a force as can be employed to best advantage on the foundation excavation is maintained at the job. It is here that the large capacity and labor-saving layout of the concrete plant has proved its value. It is possible to concrete a section in a few runs as soon as the foundation has been prepared. At the same time, as the concrete plant is able to keep up by running only a short part of the time, this method of organizing the work does not appreciably delay the excavation.

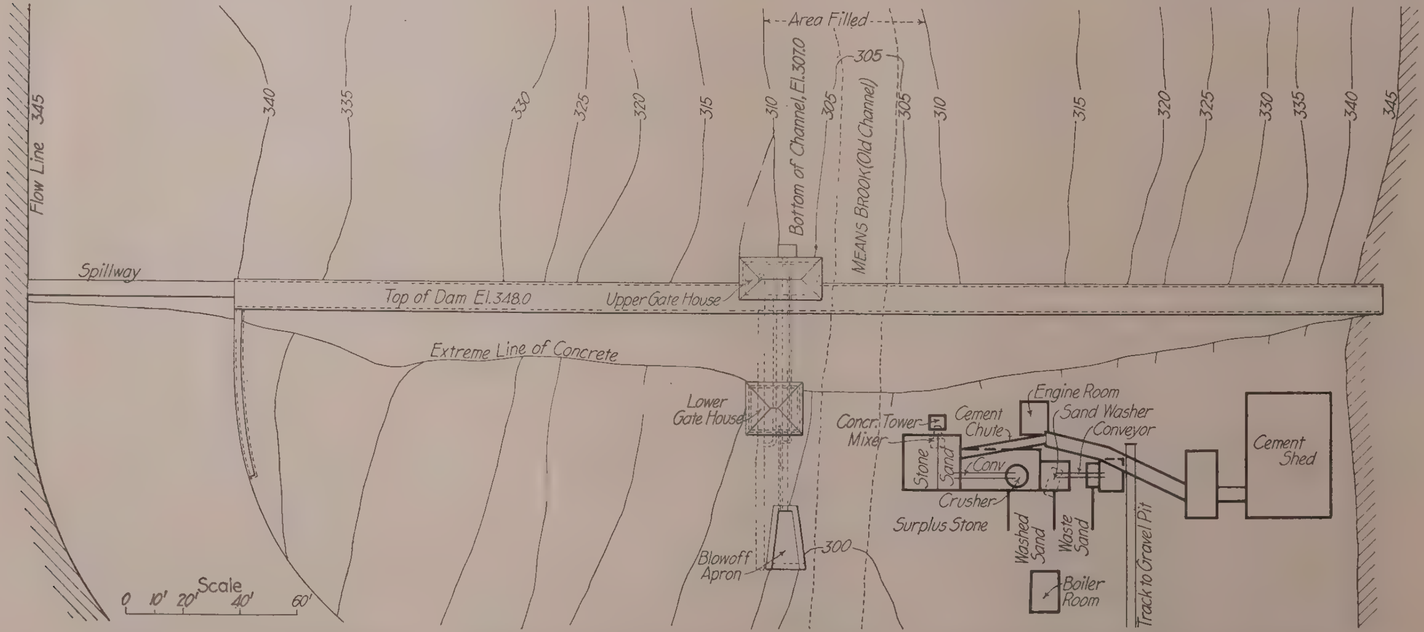
GRAVEL PIT DEVELOPED

On account of the long haul over indifferent roads, it has paid to develop a gravel deposit found in the east side of the valley a few hundred feet below the dam, although this deposit was at a low elevation and contained a large excess of sand, and although the material from it had to be washed. Cement for the work is hauled in automobile trucks from Shelton, a distance of 4 miles.

The pit is worked with a revolving steam shovel, and the 4-yd. side-dump cars used are handled on the pit floor and at the mixing plant by a dinky. A hoisting engine set at the top of the incline to the pit floor hauls the dinky and two cars at a time from the pit to the upper level. This deposit is a pocket of glacial drift, in which are many large boulders. These are blockholed and shot up for the crusher, as this is considered the cheapest method of getting them out of the way.

ECONOMICAL CONCRETE LAYOUT

A 150-ft. tower, designed to spout a distance of 250 ft., is used for placing all the concrete. The company expects to build a larger dam soon, and it was decided to try out the spouting method of placing concrete on the present job with a view to laying out the larger one more intelligently. Over the 1-yd. mixer at the base of this tower, which is located just east of the creek on the valley floor below the dam, are the stone and sand bins. Downstream from these on the valley floor are storage piles for both sand and stone, which are reached by a clamshell guy derrick. This derrick handles washed sand from the pile to the bins, while normally the stone drops directly into the bins from a revolving screen mounted above it. Crushed boulders and gravel are elevated by a bucket



LAYOUT MADE POSSIBLE LOW-COST CONCRETE WORK WITHOUT REQUIRING THAT A LARGE CREW BE HELD ON THE JOB conveyor to this bin from a No. 5 McCully gyratory crusher, set east of the bins. This crusher is fed by a chute from a grizzly screen, set above and east of it. The sand from this screen is washed down a trough directly into the sand washer, or can be run out on the ground below the storage pile for washed sand. As this surplus sand piles up, the derrick loads it back into the dump cars, and it is wasted on a dump between the plant and the pit.

The grizzly screen is fed by a bucket conveyor from a pit east of the sand washer into which the side-dump cars from the gravel pit discharge. The plant is supplied with steam by one 100-hp. and one 30-hp. boiler. The crusher is run by a belt from a horizontal engine.

The cement house is located on the hillside east of the tracks on which the dump cars operate. A runway extends from it across the tracks to a point over the crusher, whence the cement is dropped down an inclined chute to the charging platform. It has been found that keeping this chute full to the top saves the cement sacks, by reducing the speed with which the bags slide down the chute.

LEFT—LOCAL GRAVEL PIT DEVELOPED WITH INCLINED TRACK

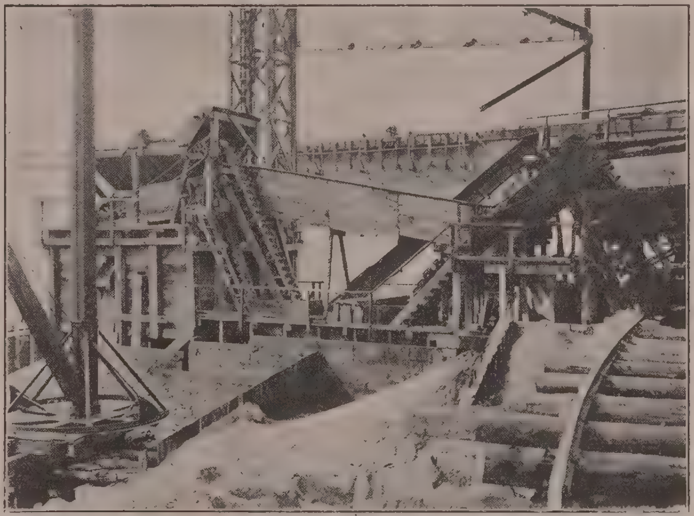
Stone Is Washed When Measured

The stone is washed in the measuring hopper, a batch at a time. A sill at the discharge gate prevents the wash water from reaching the charging hopper. This water runs out through a screen in the bottom of the measuring hopper and is carried back to the creek in a small flume. This is done on the theory that when the stone is freshly washed and still wet it not only is cleaner, but is more easily filmed and makes a better bond with the mortar.

TYPICAL SECTION OF DAM

Spouting System Works Well

The dam is concreted in 60-ft. sections, keyed to each other, and poured in 4-ft. lifts. The wooden forms are made in panels, handled by the derricks and built up in 8-ft. sections, as concreting proceeds. The rock is washed off with a high-pressure water jet and covered with 1 or 2 in. of rich mortar before concreting the base of each section. The mass concrete is mixed in the proportion of 1:2½:4½. The end of the last section of chute is handled on top of the form by a derrick, and the concrete is spouted to place without rehandling in the form.



RIGHT—MATERIALS HANDLED BY MACHINERY FROM CARS TO FORMS

Little difficulty has been experienced in making a mixture of the proper consistency flow freely through the chutes used. It is said that spouting has proved much faster than handling the concrete with derricks, as was done at the Hemlocks dam. The concrete placed appears uniformly dense, has good horizontal joints, and leaves a surface against the form which has required no plastering. Exposed surfaces are finished by wetting and rubbing them with cement bricks.

The top of the dam is surfaced with mortar. As the finish mortar has to be mixed stiff, it has, of course, to be shoveled down the chutes. This mortar is given a rough-surface sidewalk finish.

ROCK FORMATION IN FOUNDATION

Large Capacity an Advantage

The sand washer and crusher have a capacity of several hundred yards a day, while the concrete plant never has to place more than 180 yd. a day. This in turn is considerably in excess of the rate required to keep up with the excavation. All of this equipment, however, was on hand, and would otherwise have been idle. The expense of transporting it and setting it up was not much more than the same expense for lighter equipment. It has been more than justified by the fact that it has enabled a small force to keep up good progress with the work.

Excavation Handled by Derricks

One stiffleg and two guy derricks handle the earth and rock excavation. The stiffleg derrick and one guy derrick have had to be moved twice as the worked progressed. The excavated material is to be spread along the base of the dam on the upstream and the downstream sides. Several tripod drills are used on the rock excavation, and these are supplied with steam from the hoist boilers.

The strike of the gneiss formation is nearly parallel to the dam, and the dip is very sharp and toward the north. The rock, therefore, breaks out in deep, natural keyways, triangular in section, and no other key or bond between the rock and the masonry is required. The rock contains fissures near the surface, and excavation is carried down until these are entirely cut out. The upstream side of the excavation is made several feet deeper than the downstream side.

No great trouble was experienced with

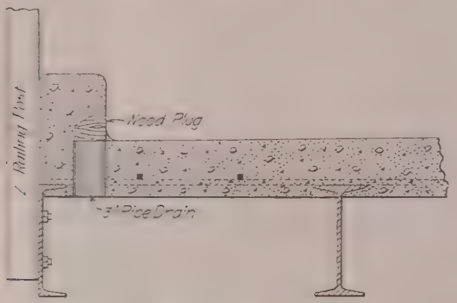
the stream during construction. It was at first diverted through a wooden flume and is now passed through pipes embedded in a finished section of the dam.

A feature of the design of the dam is a riser pipe through which all water from the reservoir flows, and the discharge of which is located 4 ft. below the spillway, so that the reservoir cannot be drawn down below that level. This was done to insure a constant stored supply for the water system of a small village in the neighborhood, which is to be supplied direct with water from this basin.

The entire work is under the direction of Samuel P. Senior, vice-president of the Bridgeport Hydraulic Company. A. B. Hill, consulting engineer for the company, made the general design for the dam, which is being built by forces of the company under Dick Hughes, superintendent. W. B. Pollitt is resident engineer.

Wisconsin Concrete Bridge Floor Drains Placed Under Curb

SIDE DRAINS under the curb, instead of vertical drains at the side of the curb, are the latest devices employed by the Wisconsin Highway Commission to avoid the danger from openings in its reinforced-concrete bridge floors, causing injury to the feet of small domestic animals, such as sheep and colts.



SIDE DRAINS PLACED UNDER CURB

The reinforced-concrete bridge floors in use in the Middle Western States are ordinarily 6 in. thick, with a curb at the outside of the roadway. The common way of providing drainage is by vertical openings through the floor at the curb. In order to remain unobstructed these openings should be at least 3 in. in diameter.

The detail designed by M. W. Torkelson, bridge engineer for the Wisconsin Highway Commission, is not easily obstructed, and consists of a 3-in. pipe, as shown in the drawing, set under the inside of the curb with the top covered with a tapering wooden plug, which is withdrawn after the concrete has set. The same result could be obtained by using an elbow in connection with the pipe, but there is not sufficient room between the edge of the channel and the inside of the 6-in. curb commonly in use, and the elbow would be more expensive than the use of the temporary plug.

PUBLIC IMPROVEMENTS AT VANCOUVER, B. C., according to a report recently issued by that city, are valued at $25,803,151. The items making up this total include the investments in streets, sewers, waterworks, schools, buildings and other improvements. In addition to the total named, there is $8,252,562 in street improvements, the greater part of which is a debt against adjacent property.

Design of Turbine Draft Tubes Analyzed

Part I—Assumptions Have to Be Made—New Formula Derived for Reduction of Velocity of Water Leaving Turbine—Shape and Size of Tube

By A. G. HILLBERG
Hydraulic Engineer, New York City

THE OVER-ALL hydraulic efficiency of a hydroelectric installation depends on the efficiencies of the various parts through which the water passes. The design of the turbine itself, naturally, is of great importance, but even the most efficient waterwheel, when mounted in a poorly designed scroll case with an inefficient draft tube, will not show a high over-all hydraulic efficiency for the plant. Vibrations in powerhouse substructures are often due to poorly designed draft tubes, in which the discharge does not fill the tube. In the upper part, where the change in elevation is more rapid than in the lower, a vacuum is formed between the stream and the walls of the draft tube, resulting, naturally, in vibration of the stream. The greater the discharge and the higher its velocity the less the vapor pressure in the vacuum and the greater these vibrations. In an article published in the Engineering Record in the issues of Oct. 2, page 413, and Oct. 9, page 442, the writer discussed the various phases of the design of large scroll cases. In this article the design of draft tubes will be treated.

Referring to the previous article, the maximum draft head of a turbine was discussed in connection with the location of the vertical center plane of the scroll case. The total draft head was referred to the difference in elevation between the top of the runner band and the lowest tail-water level. The formula arrived at read

$$E = 33.9 - (M - L) - (v^2/2g) \qquad (1)$$

where E = difference in elevation, or maximum permissible draft head; v, velocity through the runner band at full load; g, 32.16; M, margin allowed for governing and vapor tension, and L, allowance for all losses due to friction and curvature in the draft tube and the outflow loss at its end.

It was shown that the value of $(M - L)$ should be selected at from 3 to 6 ft., depending on the physical conditions of the plant in question—M depending on the load variations and L upon the length of the draft tube.

ASSUMPTIONS MUST BE MADE

In dealing with the flow in curved and expanding tubes several factors develop which prevent an absolutely correct mathematical solution of the problem. If two succeeding sections be considered, and it be assumed that the flow is normal to the first one, the expansion and the consequent reduction in thickness of the film of water, when passing through the following section, will have upset this direction of flow. The result may be an increase or a reduction of the pressure on the walls, or it may be the formation of eddies. In order to permit any kind of a mathematical solution, it is, therefore, necessary to make certain assumptions.

In this case the following assumptions have been made:

(a) The flow in the tube, because of the slight increase in areas from one section to the other, is normal to the plane under consideration.

(b) The change in velocity head should not at any time be greater than the change in elevation. (This is, of course, in order to get a certain amount of back pressure, so that the stream will expand and fill the vessel.)

In order to anaylze the problem as completely as possible, the following factors should be investigated: Shape of center line and its length; velocities and change in velocity heads; shape of areas, volume of draft tube, and time required for a particle of water to travel through the draft tube.

SHAPE OF CENTER LINE

The velocity, v_1, of the flow through the band of the runner is always known as soon as the turbine has been designed, and the desired outflow velocity v_n at the end of the draft tube can be determined from the physical conditions of the tailrace (see further under velocities). As the discharge, Q, at full load (that is, 0.8 gate opening, wider openings being considered as overloads) is known, the areas A_1 and A_n at the top and end of the tube can be calculated. $A_1 = Q/v_1$ and $A_n = Q/v_n$. As A_1 is horizontal and A_n generally vertical (and if not vertical the plane in which it is to be placed is known) the center line of the draft tube can be located.

It should be borne in mind, however, that the draft tube must be placed deep enough to permit its being sealed at all stages of the tail water. This seal refers to the lowest point of the roof of the draft tube and not necessarily to the upper edge of the end area. As the required seal only needs to be from 2 to 3 ft. it is generally sufficient to locate the upper edge of the end area about 8 to 15 in. below the lowest tailrace level. Although the benefits of bigger seals than these are not denied, every additional inch means, generally, a lot of additional excavation for the bottom of the draft tube.

When determining the shape of the curvature of the center line, several known curves lend themselves admirably for the purpose. As the single-runner turbine is of the mixed-flow type, that is, the flow is deflected from radial to axial, the center line of the draft tube should be vertical immediately below the runner. This vertical part is a direct extension of the center line of the turbine shaft, and its location is therefore known. The center point of the end area is also known, as this area has been determined as to its size and location (see "Shapes of Areas").

The center line must go through the center point of the end area and be of such shape that the extended center line of the shaft is a tangent to it. It is also desirable that the tangent to the center line at the point of its intersection with the plane of the end area is horizontal or nearly so.

SUITABLE CURVES

Curves that fill these requirements are the parabola, the ellipse, arcs of circles with short tangents at each end, and such higher-plane curves as the cubical parabola, the cissoid, logarithmic and exponential curves.

Although the parabola, the ellipse and the higher-plane curves have their advantages from a standpoint of calculation and design, they are never used because of difficulties met with in laying out the form work in the field. The curve most generally used is the arc of a circle with tangents at both ends. In laying out a center line of a draft tube in this way the radius of the arc should be as long as possible in order to minimize the losses due to the curvature.

One disadvantage of this curve, however, is that the change of curvature is small in the upper end of the draft tube, and that consequently, in order to make the stream of water fill the tube, a considerable back pressure is required. Part of an ellipse or a parabola would be better in this respect, as shown in Fig. 1.

As the drawing shows, the change in elevation is more gradual and better distributed throughout the length of a center line of parabolic shape than of one elliptical or circular. If the draft tube is short, however, the tangent at the lower end of the curve will not be horizontal, and, as it is desirable to have a horizontal or nearly horizontal discharge of the water, it is sometimes necessary to insert at this end a short arc of a circle with a long radius.

LENGTH OF CENTER LINE

The length of the center line depends on its shape, as, generally, its top and bottom co-ordinates are given. The shortest curve connecting these points is a straight line, which will be the chord of the segment formed by the curve.

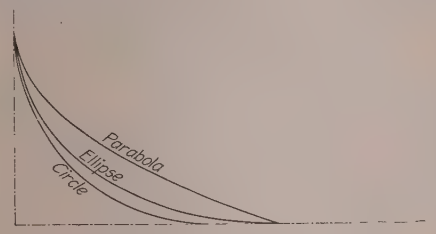


FIG. 1—CURVES FOR CENTER LINE

Should the center line be composed of short tangents connected by an arc of a circle its length can be determined by trigonometry, but if it be of elliptical, parabolic or other shape, calculus offers the most convenient way of obtaining the length. If, therefore, S is the length of the curve from the point A to B,

$$S = \int_A^B \left[\sqrt{1+\left(\frac{dy}{dx}\right)^2}\right] dx \qquad (2)$$

the proof of which can be found in any textbook on higher mathematics.

SHAPES OF CROSS-SECTIONS

As the runner band is circular, the upper end of the draft tube, in order to fit the distributor, must also be circular. The flow of the discharge below the turbine, although axial in its general direction, follows along lines of approximately helical shape, and the areas of the draft tube should, therefore, be circular until the curvature of the tube has broken up the helical flow lines and forced the flow to become perpendicular, or approximately so, to the cross-sectional areas.

The shape of the end area can be varied within a wide range, whose limits in the vertical direction are the depth of excavation and the water seal required, and in a horizontal direction the thickness of masonry between the draft tubes necessary to carry safely the weight of the power house. The least amount of excavation is required if this area is a rectangle and the intervening pier is as thin as permissible in order to carry the load. From a hydraulic point of view, on the other hand, it is better to have an area of circular cross-section. As this area, however, generally requires too much excavation in the tailrace and too much concrete in the power house, a compromise between the structurally and hydraulically best conditions is made, and the area takes an elliptical shape.

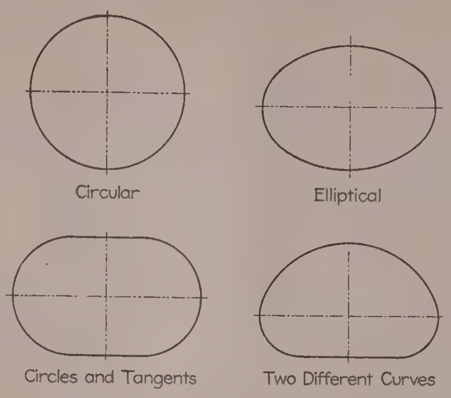


FIG. 2—FOUR POSSIBLE CROSS-SECTIONS

As elliptical forms are difficult to build the designer generally uses an area composed of two semicircles with tangents in between the major axis horizontal. In one case the end area was composed of two different curves with the same horizontal axis. (See Fig. 2.)

All intermediate cross-sectional areas must be larger than the top area and smaller than the end area. Their shape can also be varied within the limits of the shapes of the two given areas. It is, however, customary to keep the areas circular until the diameter of the circle becomes equal to the minor axis of the end area. After that point has been reached the circular shape is abandoned and the horizontal axis increased until it equals the major axis of the end area. Different designers have their own opinions about the best way of changing the shapes of the areas, and no definite rule, therefore, can be established.

VELOCITIES

The velocity of the flow at any point in a draft tube must be related, in a certain way, to the velocities at other points. The velocities at two points, however, are known at the outset; these are v_1 and v_n, the velocities at the top and end of the tube. For the former,

$$v_1 = 0.3 \text{ to } 0.4\sqrt{2gh_o} \qquad (3)$$

where

$$h_o = h_a - (\sqrt{h_a}/3) \qquad (4)$$

For the deduction of the formula for h_o see the previous article in the Engineering Record of Oct. 2, page 414. In the formula for v_1 the operating head of the plant is h_o.

The turbine builder will give the velocity of flow as soon as the runner of the wheel has been designed. If it be required to design a draft tube for estimating purposes before the turbine has been designed finally, it is better to assume too high than too low a value.

The outflow velocity v_n should be kept as small as possible in order to waste a minimum of the head. Usually

$$v_n = 0.05 \text{ to } 0.1\sqrt{2gh_o} \qquad (5)$$

but a few cases have been recorded in which v_n has been even less than $0.05\sqrt{2gh_o}$. It is not always advantageous to use a small value of v_n, as the flow in the tailrace must be rapid enough to carry away the water. A low value of v_n might, therefore, result in an unnecessarily expensive excavation for the tailrace. As a low velocity requires a bigger area for the outflow, too low a velocity might also result in a longer spacing of the wheel centers, thus increasing materially the cost of the power house.

By means of these velocities the corresponding cross-sectional areas A_1 and A_n can be calculated, as the discharge Q is known. The intermediate areas can be calculated only after the velocities through the planes in which these areas are located have been determined. The problem, therefore, is to find the velocity change per length unit in the draft tube measured along the center line.

CHANGE IN VELOCITY HEAD LESS THAN CHANGE IN STATIC HEAD

It must be remembered, however, that this change in velocity must be such that the change in velocity head becomes somewhat smaller than the change in static head. The idea is that on one side the film of water is subjected to a pressure corresponding to the change in velocity head, and, on the other, to a pressure corresponding to the change in static elevation. If the difference in pressures be such that the film is subjected to a back pressure, the film will obviously expand sideways and thus fill the cross-sectional area of the tube. Applying the theorem of Bernouilli to this case,

$$(v_a^2/2g) + P_a + h_a = (v_{a+1}^2/2g) + P_{a+1} + h_{a+1}$$

but in accordance with assumption b,

$$(v_a^2/2g) - (v_{a+1}^2/2g) = h_{a+1} - h_a \qquad (6)$$

so that $P_a = P_{a+1}$, or, in other words, the pressure remains constant.

If equation 6 is satisfied for the full-load discharge through the draft tube, it is true that for smaller discharges

$$(v_a^2/2g) - (v_{a+1}^2/2g) < h_{a+1} - h_a$$

Consequently there will be a back pressure

$$P = (h_{a+1} - h_a) - [(v_a^2/2g) - (v_{a+1}^2/2g)]$$

In this formula h_a and h_{a+1} are the static elevations at the points a and $a+1$ on the center line, while v_a and v_{a+1} are the corresponding velocities.

In any two succeeding sections

$$v_a A_a = v_{a+1} A_{a+1} = Q$$

Therefore

$$v_a = \frac{A_{a+1}}{A_a} v_{a+1}$$

and

$$v_a^2 = \left(\frac{A_{a+1}}{A_a}\right)^2 v_{a+1}^2$$

Substituting v_a in equation 6,

$$(v_{a+1}^2/2g)\left(\frac{A_{a+1}}{A_a}\right)^2 - \frac{v_{a+1}^2}{2g} = h_{a+1} - h_a$$

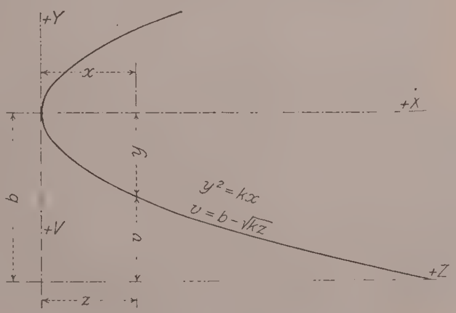


FIG. 3—DIAGRAM TO DERIVE EQUATION 8

so that

$$v_{a+1}^2 = \frac{2g}{\left(\frac{A_{a+1}}{A_a}\right)^2 - 1} (h_{a-1} - h_a)$$

This equation represents a parabola, and it proves that the velocity should be retarded in accordance with a curve cut from one of the branches of a parabola. The equation can be written

$$y^2 = kx \qquad (7)$$

CO-ORDINATES MUST BE SHIFTED

This equation is very convenient, but, unfortunately, it is not directly applicable to the problem. In order to make it applicable it is necessary to shift the X-axis so that the apex of the curve will be located on the Y-axis at a point with the co-ordinates 0 and b (Fig. 3).

Calling the new system of axes V and Z, any points on the curve that formerly had the co-ordinates x and y will now have the co-ordinates z and v. Of these co-ordinates $z = x$ and $y + v = b$, or $y = (b - v)$, so that $(b - v)^2 = kx$, or

$$v = b \mp \sqrt{kz}$$

As in this case the lower branch of the curve only is used, equation 7 finally becomes

$$v = b - \sqrt{kz} \qquad (8)$$

Referring to Fig. 4, v_1 is the velocity at the top of the draft tube; v_n, the velocity of the outflow; l, the length of the tube measured along its center line; z_1 and z_n, the abscissas of the ordinates v_1 and v_n.

ONLY ONE OF THREE POSSIBILITIES DESIRABLE

Three different possibilities now obtain

(1) $v_1 + v_n > y_1 + y_n$
(2) $v_1 + v_n = y_1 + y_n$
(3) $v_1 + v_n < y_1 + y_n$

In case 1 there is obvious danger that the change in velocity may become too great in the beginning of the tube, provided the difference is considerable. In case 3 it is apparent that if the difference is considerable the velocity curve becomes practically a straight line, which is not desirable. Consequently only case 2 needs further examination.

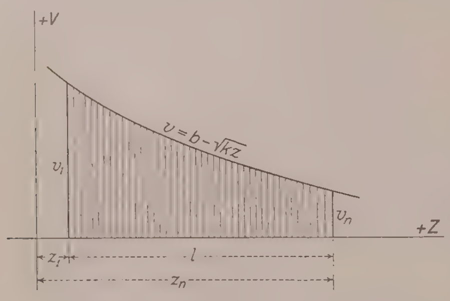


FIG. 4—FOR VELOCITY ANALYSIS

Since $y + v = b$ in this case, $y_1 + v_1 = b$ and $y_n + v_n = b$, or

$$y_1 + v_1 = y_n + v_n$$

But

$$v_1 + v_n = y_1 + y_n$$

so that

$$v_1 + y_1 = v_n + y_n$$

and

$$v_1 - y_1 = -v_n + y_n$$

or

$$2v_1 = 2y_n$$

Thus $v_1 = y_n$ and $v_n = y_1$, so that

$$b = v_1 + v_n \qquad (9)$$

Substituting the co-ordinates z_1 and v_1, and z_n and v_n, in equation 8, it becomes

$$v_1 = b - \sqrt{kz_1}$$

and

$$v_n = b - \sqrt{kz_n}$$

Or

$$b - v_1 = \sqrt{kz_1}$$

and

$$z_1 = \frac{(b - v_1)^2}{k}$$

In the same way it is proved that

$$z_n = \frac{(b - v_n)^2}{k}$$

But

$$b = v_1 + v_n$$

so that

$$z_1 = v_n^2/k \text{ and } z_n = v_1^2/k$$

From Fig. 4 it is obvious that $l = z_n - z_1$, so that

$$l = \frac{v_1^2}{k} - \frac{v_n^2}{k} = \frac{1}{k}(v_1^2 - v_n^2)$$

which gives

$$k = (v_1^2 - v_n^2)/l \qquad (10)$$

Introducing the values found in equations 9 and 10, in equation 8 it becomes

$$v = (v_1 + v_n) - \sqrt{\frac{v_1^2 - v_n^2}{l} z} \qquad (11)$$

This is a convenient expression giving directly the velocity at any point z on the center line. As mentioned previously, v_1, v_2 and l have already been determined and can be considered constant quantities at this stage of the calculation.

It is now required to locate the ordinates v_1 and v_n on the Z-axis. Substituting in equation 11 the co-ordinates z_1 and v_1 it becomes

$$v_1 = (v_1 + v_n) - \sqrt{\frac{v_1^2 - v_n^2}{l} z_1}$$

so that

$$v_n = \sqrt{\frac{v_1^2 - v_n^2}{l} z_1}$$

or, solving for z_1,

$$z_1 = \frac{l}{\left(\frac{v_1}{v_n}\right)^2 - 1} \qquad (12)$$

and

$$z_2 = l + z_1 \qquad (13)$$

Equations 12 and 13 locate the ordinates v_1 and v_n on the Z-axis. As v_1 always is larger than v_n, the term $(v_1/v_n)^2$ is greater than one, and, consequently, z_1 always positive.

A table is now established giving the number of points on the center line, their distance from the upper end; z, the abscissas on the axis; v, the velocities; $v^2/2g$, the velocity heads; the difference in velocity heads; the static elevations of the points; the differences in elevation; the areas of the cross-sections, and the shapes of the areas. (For such a table see the problem.)

TIME

When a particle of water is passing through the tube its motion is assumed to be curvilinear. Therefore $v = \mathrm{d}z/\mathrm{d}t$. As in this case the abscissas x equal the abscissas z and the ordinates y equal $(b - v)$, it is obvious that for calculating the time required it is just as correct to use the parabola $y^2 = kx$ as it is to use $v = b - \sqrt{kz}$. But in this case $y_1 = v_n$ and $v_1 = y_n$, so that

$$k = \frac{y_n^2 - y_1^2}{l} = \frac{v_1^2 - v_n^2}{l}$$

As $x = z$ it is obvious that

$$v = \mathrm{d}z/\mathrm{d}t = \mathrm{d}x/\mathrm{d}t$$

and

$$v^2 = \left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2$$

Hence

$$\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2 = kx$$

and

$$\mathrm{d}t = \mathrm{d}x/\sqrt{kx}$$

Integrating this equation between the limits x_1 and x_n, we have

$$t = \frac{1}{\sqrt{k}} \int_{x_1}^{x_n} \frac{\mathrm{d}x}{\sqrt{x}} = \frac{2}{\sqrt{k}} \Big|_{x_1}^{x_n} \sqrt{x}$$

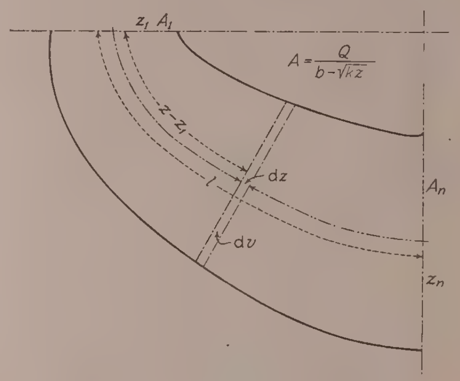


FIG. 5—FOR VOLUME ANALYSIS

Hence

$$t = \frac{2(\sqrt{x_n} - \sqrt{x_1})}{\sqrt{k}}$$

But $x_n = z_n$ and $x_1 = z_1$. Therefore

$$t = \frac{2(\sqrt{z_n} - \sqrt{z_1})}{\sqrt{k}} \qquad (14)$$

VOLUME

When it is desired to estimate the yardage of concrete in the power-house substructure it is necessary to know the volume of the draft tube. This volume is generally estimated by dividing up the draft tube in sections and assuming each one to be a frustum of a cone. A more accurate method is to divide the tube into horizontal layers from 1 to 2 ft. thick, and estimate the volume of each layer. Both methods require considerable work and the final total is only approximate. The number of operations is also considerable, thus increasing the danger of error.

The equation of the velocity curve for the draft tube read

$$v = b - \sqrt{kz}$$

where $b = (v_1 + v_n)$ and $k = (v_1^2 - v_n^2)/l$. In any cross-section $Q = Av$, where Q is the discharge, A the area and v the velocity. Hence $v = Q/A$. Introducing this in the equation for v,

$$Q/A = b - \sqrt{kz}$$

or

$$A = \frac{Q}{b - \sqrt{kz}} \qquad (15)$$

The infinitesimally small volume of a film of water in the draft tube (Fig. 5), therefore, is

$$\mathrm{d}v = A\mathrm{d}z = \frac{Q\mathrm{d}z}{b - \sqrt{kz}}$$

or

$$V = Q \int_{z=z_1}^{z=z_n} \frac{\mathrm{d}z}{b - \sqrt{kz}} = \frac{Q}{b} \int_{z=z_1}^{z=z_n} \frac{\mathrm{d}z}{1 - \frac{\sqrt{k}}{b}\sqrt{z}}$$

Differentiating,

$$\sqrt{z}, d(\sqrt{z}) = \frac{dz}{2\sqrt{z}}$$

or

$$dz = 2\sqrt{z} d(\sqrt{z})$$

If now $\sqrt{z} = y$; $d(\sqrt{z}) = dy$, so that $dz = 2ydy$. Introducing this in the equation for V,

$$V = \frac{2Q}{b} \int_{z_1}^{z_n} \frac{ydy}{1 - \frac{\sqrt{k}}{b} y}$$

Integrating,

$$V = \frac{2Qb}{k} \Bigg|_{z_1}^{z_n} \left\{ \left[1 - \frac{\sqrt{k}}{b} y \right] - \ln \left[1 - \frac{\sqrt{k}}{b} y \right] \right\}$$

But $y = \sqrt{z}$, so that, when the limits are introduced,

$$V = \frac{2Qb}{k} \left\{ \left[1 - \frac{\sqrt{k}}{b} (\sqrt{z_n} - \sqrt{z_1}) \right] - \ln \left[1 - \frac{\sqrt{k}}{b} (\sqrt{z_n} - \sqrt{z_1}) \right] \right\} \quad (16)$$

Equation 16 gives directly the exact volume of the draft tube between any limits z_1 and z_n. The total volume is obtained by introducing the abscissas, z, corresponding to the entrance and outflow velocities. In order not to complicate the equation the expressions for b and $\sqrt{k}$ have not been introduced.

The equation can be made somewhat shorter by introducing

$$m = \left[1 - \frac{\sqrt{k}}{b} (\sqrt{z_n} - \sqrt{z_1}) \right]$$

in which case it reads

$$V = \frac{2Qb}{k} (m - \ln m) \quad (17)$$

(To be concluded)

BRICK HIGHWAYS TOTALING 37 MILES in length have been built in the State of Washington. These pavements are from 16 to 18 ft. wide, and cost, with reinforced-concrete base, from \$28,000 to \$32,000 per mile.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Information Wanted as to Society Employment Bureaus

SIR: It is possible that the Western Society of Engineers, 1745 Monadnock Block, Chicago, may attempt seriously the establishment of an employment bureau for the benefit of technical men and the employers of technical men.

Your active co-operation is desired. We wish to receive from officers and past officers of societies that have made similar attempts the reasons why the attempts failed, if they failed, and what degree of success was encountered. We would like to hear from every man who has any ideas on the subject, and the undersigned will not be appalled if the mails are filled with letters of advice or information. The task if properly attempted is a big one, we know, hence the desire to receive the benefit of experience and information which is certainly available.

ERNEST MCCULLOUGH,
First Vice-President, Western Society of Engineers.
Chicago.

Cast-Iron Pipe Makes Good Record in Galveston Storm

SIR: The following information regarding the storm damage at Galveston, Aug. 16 and 17, will supplement the information contained in the Engineering Record of Aug. 28, page 271, Oct. 23, page 500, and Nov. 6, page 576.

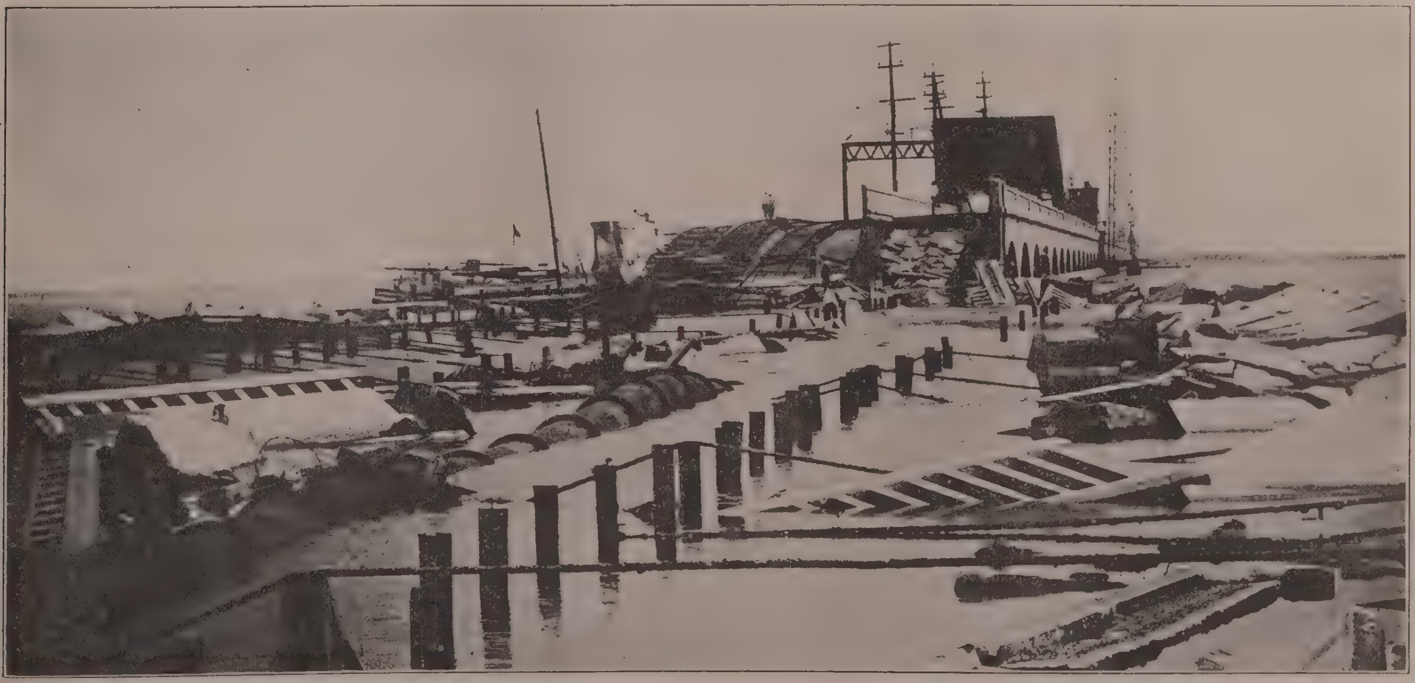
The portion of the water supply main crossing Galveston Bay is 10,800 ft. in length, and was built under the pavement of the causeway. The picture shows the condition of the pipe line after the storm. The protected roadway from the arch bridge to the mainland, and from the arch bridge to Galveston Island was almost completely destroyed for a total distance of 8500 ft.

The water main, 30 in. in diameter, was laid at an elevation of 10 to 14 ft. above mean low tide, and after the storm was found from 8 to 18 ft. lower than its original grade. In the 8500 ft. of pipe washed down only seven breaks were found, including the two breaks at the ends of the arch bridge.

This line is class B pipe made and carefully tested according to the American Waterworks Association specifications, and very carefully laid, all joints being poured and finished 2 in. deep. In many places where settlement caused abrupt angles the lead was pulled out of the joints from 1 to 1½ in. Air pressure of 30 lb. per square inch failed to show any serious leaks except at the seven breaks mentioned above, and no pipe was broken. This seems remarkable when one considers the stress sustained during the storm. The wind reached a velocity of 100 miles per hour, producing a tide elevation of 17.4 ft. at the causeway, and a current of very high velocity at right angle to the pipe line.

Repairs to this line were made with considerable difficulty on account of the pipe having settled several feet below water where serious breaks occurred, being covered with concrete slabs and other debris and in many places having several feet of water under the pipe. Where the line was submerged divers were used to place sleeves and fill joints, and in other places a derrick barge was used to raise the line sufficiently to permit repairs.

During the progress of this work, about 18 days, Galveston secured water through a temporary 8-in. line and through a dupli-



STORM CAUSED ONLY SEVEN BREAKS IN GALVESTON'S 30-IN. CAST-IRON WATER SUPPLY LINE cate 30-in. submerged line which had been repaired.

A. T. DICKEY,
City Engineer.

Galveston, Texas.

Tests Prove Lug Angles Valueless

SIR: I wish to thank you for the abstract in the issue of Oct. 23, page 512, of my paper on "The Effect of the End Connections on the Distribution of Stress in Certain Tension Members," and also for your remarks on page 497 of that issue. It is gratifying that a wide publicity should be given to these tests, which appear to me to have a somewhat important practical bearing. At the same time I fear that I do not find myself in entire agreement with all that you write in your editorial. You state that "in many cases joint detailing is simplified by avoiding long, single lines of rivets in the connection plates and the advantage in smaller gussets tends to offset the cost of using lug angles." My objection to this will be best stated by quoting a paragraph from the original paper (page 168), omitted in the abstract which you publish:

"To sum up, it may be said that in neither the single nor double angles does the lug angle cause a displacement of more than 0.1 in. in the line of pull either parallel or perpendicular to the end plate, and that this produces only small changes in the maximum stress, insignificant in comparison with those arising from the stiffness of the gusset plate in its own plane. The effect of the lug angle is thus so small as to be practically negligible. It is also uncertain, since, depending upon the stiffness of the gusset plate, which is difficult to predict, it may increase or diminish the maximum stress. The contention that the lug angle increases the virtual length of attachment of the main angle to the gusset plate, allowing more rivets to be used, is also seen to be incorrect, since practically none of the stress is transmitted into the angle through the rivets in the lug angle, at any rate until the member is near to the breaking load, when it is of no importance."

This applies, of course, only to members such as are dealt with in the paper. There may be special cases in which lug angles are of value.

Montreal. CYRIL BATHO.

[Although tests may not justify the practice, it is customary to design these connections by counting the rivets in the lug angles for their full value. The shortening of the connection mentioned in the editorial results from this practice, which these tests evidently discredit.—EDITOR.]

Comparing Sewer Sections

SIR:—The paper by Prof. R. DeL. French of McGill University, which appears in your issue of Aug. 21, page 222, has interested me very much. One thought which runs through the article seems to be that, except for very small percentages of total capacities, the various shaped sewers now in general use are not so good as, or at any rate not better than, the circular sewer which, for a given area, of course, has the least material in it. The advantages of the egg-shaped sewer, for instance, are clearly shown by his curves to be evident to an appreciable degree only when the sewer is flowing about one-tenth full. This greater velocity at a lower percentage of capacity is supposed to be desirable in eliminating sediment during the low water stages.

All this pro and con is on the supposition that the sewer is clean, but a glance at Mr. French's diagrams "a" and "b" will immediately show that the angle of two lines tangent to the periphery at the water surface during the low stages is very much greater in the circle than in the egg shape. If we should set up two pairs of smooth boards in the shape of troughs, each trough at an angle corresponding to these two sections, and endeavor to draw an ordinary brickbat through them, the friction would be much greater in pulling through the narrow trough than through the flat wide one. From this fact we might advance the theory that the narrow invert of the egg-shaped sewer offered more resistance to sliding obstacles than the round sewer.

I had an opportunity last spring to observe whether there was anything in this theory during an investigation of the old sewers of Milwaukee, which, however, was not carried on with this particular feature in mind. I inspected the Milwaukee sewers in more than fifty places and, although Milwaukee is not by any means a flat city, I found that in every case the egg-shaped sewers were very much more clogged up with sediment than the round ones of approximately the same capacity; in fact, the sediment had reached such a depth in the egg-shaped sewers that they were practically round sewers with an invert offering considerably more resistance than that of the round sewers. This sediment not only acted as an impediment and a reducer of the cross-section, but seemed to offer a means of retaining sewage at a low-stage season until it had become very septic; and as a consequence the inverts of these egg-shaped sewers were noticeably softer on the surface and blackened throughout the section by the sulphurous products of sewage decomposition. This was true, of course, in a measure of both the round and the egg-shaped sewers, but more noticeable in the egg-shaped; and the cases of complete disintegration which I noticed were all in egg-shaped sewers.

If these observations could be duplicated in other places so as to make sure there was no special reason for the collection of sediment under the conditions which I observed, they would form a very strong reason for abandoning the egg-shaped sewer altogether because they would take away the only excuse it has for existence.

BENJAMIN BROOKS,
Engineer.

Kansas City, Mo.

SIR:—R. DeL. French makes a hydraulic comparison of different sewer sections in the Engineering Record of Aug. 21, page 222, which interests the writer very much. I believe that a proper selection of a sewer section cannot be made without such a study of the hydraulic value of different sections. I notice that Mr. French makes his comparison of velocities on the basis of the depth of flow in the circular section. The same quantity of water which flows at a certain depth in the circle will flow at widely different depths in the other sections. It was for this reason that O. L. Eltinge and the writer made such a comparison on the basis of decimal parts of the common capacity of all the filled sections in the Engineering Record of July 26, 1913, page 112. It might be worth while to make a comparison of the relative depths of flow on the same basis.

The calculations for our diagram were very similar to those of Mr. French, but we differed from him in finding that the relative velocity of the egg-shaped section as compared with the circular section when both are loaded to their capacity was 97.8 per cent of the velocity of the sewage in the circular section instead of 95.7 per cent. In reducing the proportionate velocities of the egg-shaped to their proper proportions of the filled circular sections, Mr. French divides them by 95.7 per cent, when they should be multiplied by 95.7 per cent. By Mr. French's argument a certain percentage of 95.7 per cent is more than that percentage of 100 per cent.

The thirty sewer sections shown herewith are considered by Mr. Eltinge and the writer to be the typical sections of American and European practice. The dimensions, area, perimeter and hydraulic radius of each section are expressed in terms of one of the main dimensions of the section. The constants x and y shown with each section are exact factors by which the capacity and velocity of each section can be determined from any diagram giving the capacity and velocity of circular sewers. These factors are absolutely independent of any particular flow formula, friction factor or slope.

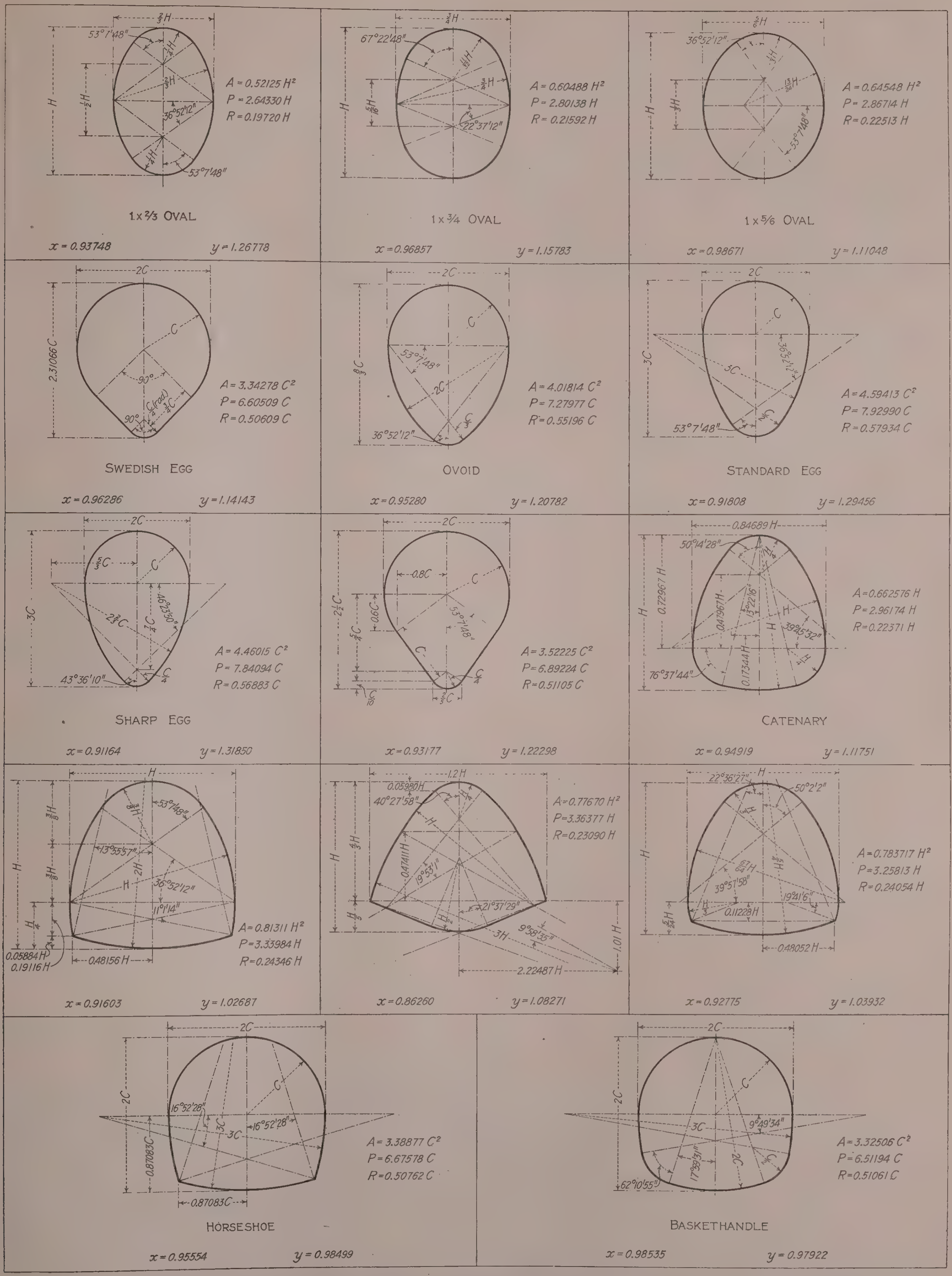
If it is desired to find the dimensions of a standard egg-shaped sewer with a friction factor of $n = 0.013$, which will have a capacity of 83.42 sec.-ft. on a 0.1-per cent grade, multiply 83.42 by its x factor, 0.91808. The result is 76.59 sec.-ft. It is found from any circular sewer diagram that a circle of 4.83-ft. diameter has this second capacity under the same conditions. Its velocity of flow is 4.18 ft. per second. The required egg-shaped sewer has this same velocity and the height of the section is found by multiplying the diameter 4.83 ft. by the egg-shape y factor 1.2946. The result is 6.25 ft. or 75 in.

The derivation of these factors is very simple. In all of the accepted hydraulic formulas the area and hydraulic radius are the only functions of the shape of any section which determine its capacity and the velocity of flow. Any two sections with equal hydraulic radii have the same velocity of flow, regardless of their relative shapes or areas. The hydraulic radius of any section is its area divided by its wetted perimeter, or expressed algebraically, $r = A/P$, or $A = pr$. For the circle $r = \frac{1}{4}\pi D^2/\pi D = D/4$.

Sub-zeros are used to designate functions of the circular section which has the same hydraulic radius as the section under investigation. Since the hydraulic radius of every circular section is $D/4$, the diameter of the circle which has the same velocity of flow as any other particular section is equal to four times the hydraulic radius of that section.

Q for the section $= AV = prV$ and $Q_o = A_oV = P_orV$. From this $Q_o/Q = P_orV/PrV = P_o/P$, or $Q_o = QP_o/P$. The factor x shown with each section is P_o/P; it is the factor by which to multiply the capacity of the required section to find the capacity of the circular sewer having the same velocity of flow. The factor y is the height of the section divided by the height of the circular section having the same hydraulic radius.

ROBERT S. BEARD,
Assistant Engineer, City Engineer's Office.
Kansas City, Mo.



1 x ⅔ OVAL
$A = 0.52125\,H^2$
$P = 2.64330\,H$
$R = 0.19720\,H$
$x = 0.93748$ $y = 1.26778$

1 x ¾ OVAL
$A = 0.60488\,H^2$
$P = 2.80138\,H$
$R = 0.21592\,H$
$x = 0.96857$ $y = 1.15783$

1 x ⅚ OVAL
$A = 0.64548\,H^2$
$P = 2.86714\,H$
$R = 0.22513\,H$
$x = 0.98671$ $y = 1.11048$

SWEDISH EGG
$A = 3.34278\,C^2$
$P = 6.60509\,C$
$R = 0.50609\,C$
$x = 0.96286$ $y = 1.14143$

OVOID
$A = 4.01814\,C^2$
$P = 7.27977\,C$
$R = 0.55196\,C$
$x = 0.95280$ $y = 1.20782$

STANDARD EGG
$A = 4.59413\,C^2$
$P = 7.92990\,C$
$R = 0.57934\,C$
$x = 0.91808$ $y = 1.29456$

SHARP EGG
$A = 4.46015\,C^2$
$P = 7.84094\,C$
$R = 0.56883\,C$
$x = 0.91164$ $y = 1.31850$

$A = 3.52225\,C^2$
$P = 6.89224\,C$
$R = 0.51105\,C$
$x = 0.93177$ $y = 1.22298$

CATENARY
$A = 0.662576\,H$
$P = 2.96174\,H$
$R = 0.22371\,H$
$x = 0.94919$ $y = 1.11751$

$A = 0.81311\,H^2$
$P = 3.33984\,H$
$R = 0.24346\,H$
$x = 0.91603$ $y = 1.02687$

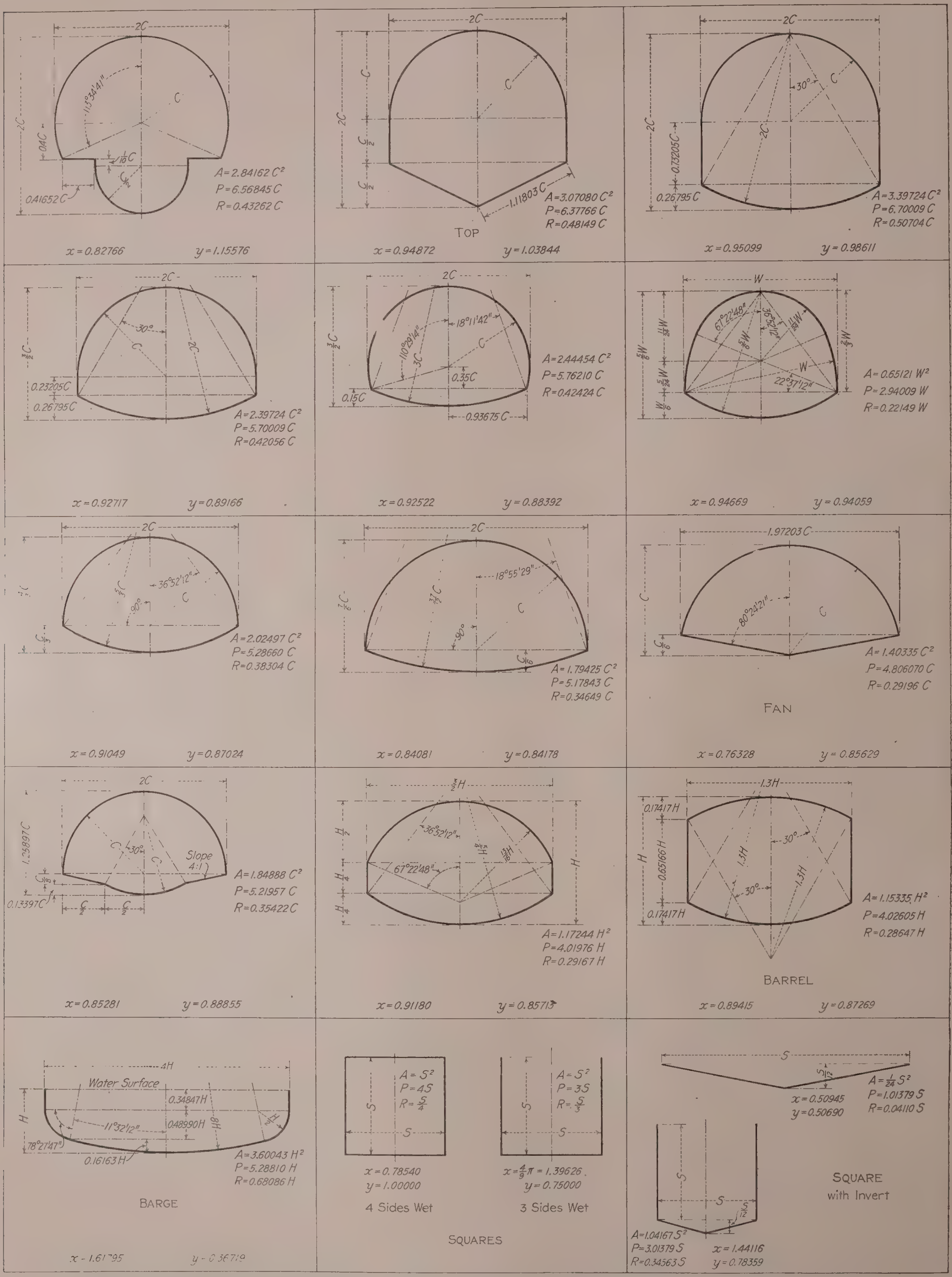
$A = 0.77670\,H^2$
$P = 3.36377\,H$
$R = 0.23090\,H$
$x = 0.86260$ $y = 1.08271$

$A = 0.783717\,H^2$
$P = 3.25813\,H$
$R = 0.24054\,H$
$x = 0.92775$ $y = 1.03932$

HORSESHOE
$A = 3.38877\,C^2$
$P = 6.67578\,C$
$R = 0.50762\,C$
$x = 0.95554$ $y = 0.98499$

BASKETHANDLE
$A = 3.32506\,C^2$
$P = 6.51194\,C$
$R = 0.51061\,C$
$x = 0.98535$ $y = 0.97922$

TYPICAL AMERICAN AND EUROPEAN SEWER SHAPES COMPARED WITH CIRCLES ON BASIS OF CAPACITY AND VELOCITY



TYPICAL AMERICAN AND EUROPEAN SEWER SHAPES COMPARED WITH CIRCLES ON BASIS OF CAPACITY AND VELOCITY

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

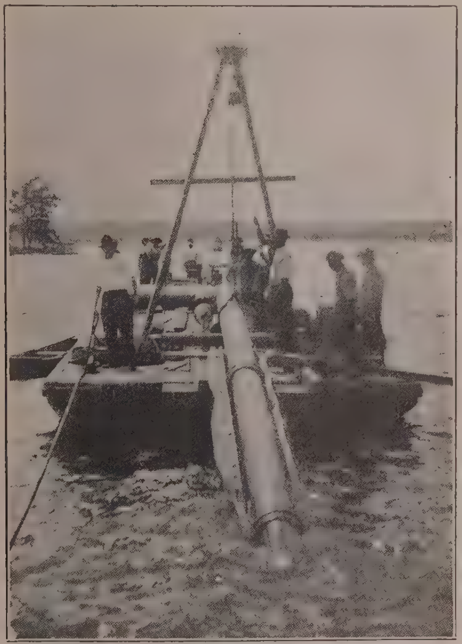
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Barge with Skidway Lays 300-Ft. Line of 12-In. Pipe in Five Hours

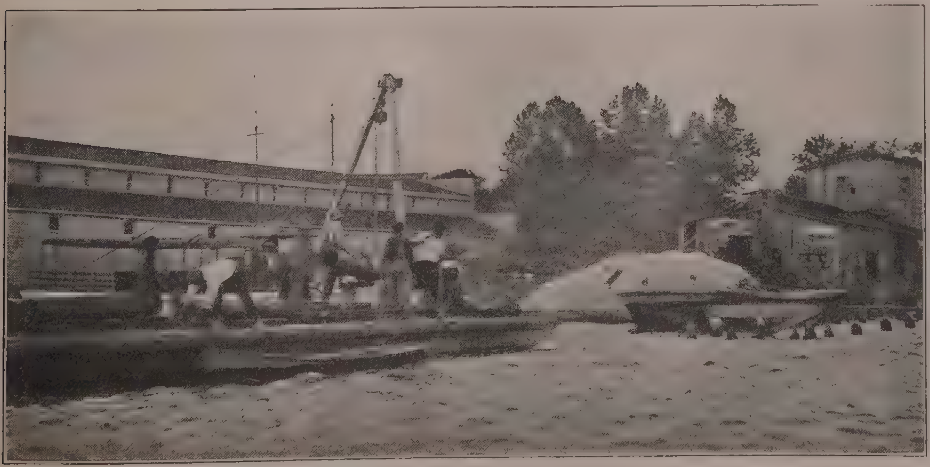
By A. G. ELLIOT
Mullins, S. C.

THREE HUNDRED feet of 12-in. cast-iron pipe were laid by the rig shown in the accompanying illustrations from the shore out to a depth of 15 ft. in five hours at Washington, N. C., recently. Only one small leak, which was easily fixed, developed in the twenty-five joints.



SIMPLE BUT EFFECTIVE SKIDWAY

The rig consisted of an inclined skidway, made of old rails spiked to heavy timbers, and suspended between two barges with its upper end resting on the outer barge. Over this end was erected an A-frame for handling the pipe. The 12-ft. lengths were carried on the outer barge, set on the skidway with tackle and calked above water. The outer end of the skidway was supported from a cable hung from a second barge, and kept far enough from the bottom to give the pipe line a long, easy curve. The barges were withdrawn from the outer end as the lengths were laid. As the joints of ordinary cast-iron pipe are not flexible, this part of the work required great care to prevent breaking the pipe. The work was done without a diver, and at a cost of less than 75 cents a foot, exclusive of the pipe, which was furnished by the city. The writer was the representative on the work of Gilbert C. White, consulting engineer, of Charlotte, N. C.

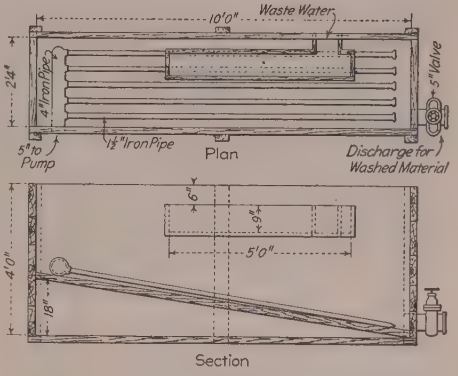


BARGE DURING OPERATION SHOWN LAID 500 FT. OF PIPE IN 5 HOURS

Continuous Washer Cleans 250 Yards of Sand a Day

IN THE sand washer illustrated herewith water comes up through the sand from the bottom. The washer was inexpensive to build, and thoroughly cleans 250 cu. yd. of dirty sand in a 10-hr. day. It was built for the concrete plant at the Means Brook dam of the Bridgeport Hydraulic Company, described elsewhere in this issue. The idea was not original with the Bridgeport Hydraulic Company, but has been improved by their engineers on successive jobs until what is thought to be a most efficient sand washer has been developed.

The rapid action of the washer is due to the mechanical stirring and washing of the sand by the water, which escapes under about 50-lb. pressure through perforations in several coils of pipe laid in the bottom of the box. The washer operates continuously, the sand being drawn out at the bottom at the same rate as it is taken in at the top. If the dirty sand comes too rapidly, it is diverted momentarily to a waste sand pile. The sand is washed down a flat trough with baffle-plates into the box, through which the water is already running. The dirt is washed out and carried, suspended in the water, into the overflow trough along one side of the box. Clean sand is drawn out through a 5-in. gate valve on a short nipple built into the lower end of the box near the bottom. The head of water in the box washes the sand out through this pipe at a rapid rate and deposits it on the storage pile, at the head of which the washer is located. The sand used on this work contains considerable fine clay, yet it is thoroughly cleaned by one trip through the washer.



WATER BOILS UP THROUGH SAND FROM PIPE COIL ON BOTTOM

Gasoline Pump Kept from Losing Prime with Water Low in Sump

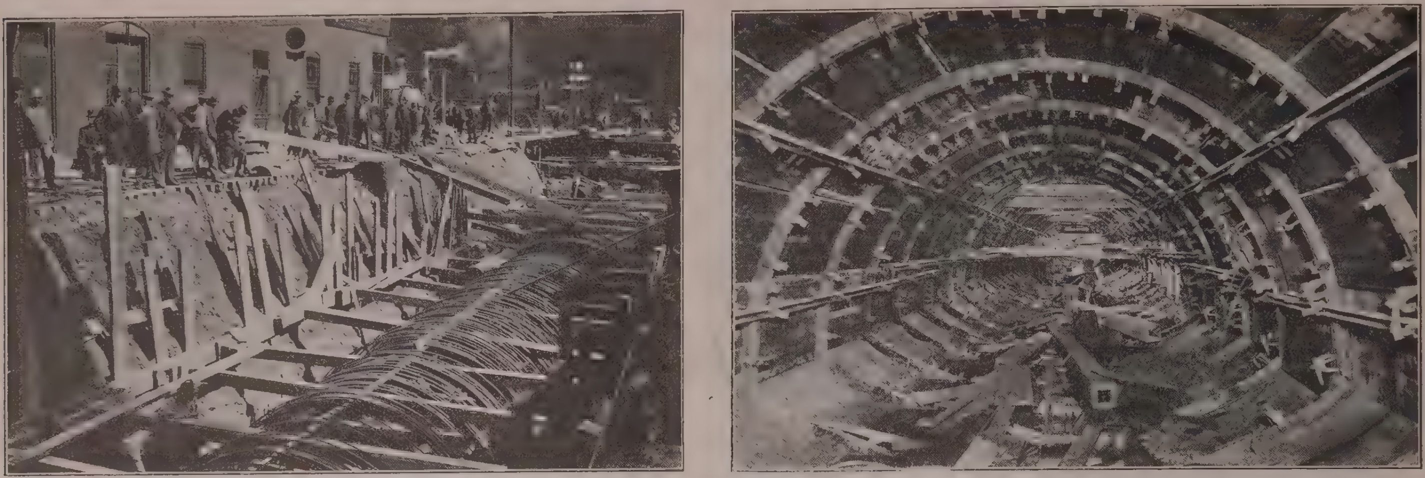
By WILLIAM G. BROADHURST
President, F. R. Long-W. G. Broadhurst Company,
Hackensack, N. J.

IN PUMPING out a cofferdam with a 4-in. centrifugal pump driven by a gasoline engine, it was found difficult to get out the last of the water. When the water was low, the pump took water out of the sump faster than it ran in, emptying the sump and causing the pump to suck air which necessitated shutting down the engine and priming the pump. While this was being done, the water would rise again.

The difficulty was overcome by opening the switch controlling the ignition of the engine for a few seconds just as the pump was about to suck air. This caused the engine and the pump to slow down so that the pump would not lift the water, which then accumulated in the sump. Before the engine stopped entirely, the switch was closed and the pump started again and run a few seconds. By repeating this operation several times the cofferdam was pumped practically dry without once having to prime the pump.

Extra Detonators in Long Blast Useless Unless Connected

EXTRA DETONATORS for hastening the explosion of a long charge of dynamite or powder are worthless unless connected to the firing circuit, according to experts of the U. S. Bureau of Mines. Experiments made by the Bureau and described by Charles Munroe and Clarence Hall in *Bulletin* 80 indicated that the explosive wave caused by the first detonation exploded the dynamite surrounding the other detonators



REINFORCING HUNG FROM TRENCH BRACES TILL SIDE-WALL CONCRETE SETS—INTERIOR VIEW SHOWS HOW FORMS ARE HANDLED

before these detonators themselves went off, unless they were placed 5 in. apart or less. One test with this very close spacing indicated a slight acceleration of the explosion with an insensitive dynamite. The experiments were made by putting up 1¼-in. sticks of dynamite in cartridges made of 1½ and 1¾-in. pipe 42 to 80 in. long, with only the end blasting cap connected to the firing battery. A long charge can, of course, be detonated much more quickly by putting a blasting cap in each end and connecting both to the battery.

Boom Conveyor Builds Concrete Cottages in 3½ Hours Each

BY THE SIMPLE boom concrete conveyor shown in the accompanying photograph a contractor at Euclid Beach near Cleveland exceeded Edison's dream of building a house a day and built the one-story cottage in 3½ hr. On the conveyor chain, which runs at quite a high speed, are sheet-metal paddles cut to the same diameter as the steel-lined trough in which the paddles run. The chain is driven by a sprocket wheel on a gasoline engine at such a speed that the concrete is shot into a head or baffle plate at the top with considerable force. It then drops into a chute conveying it into the Pressed Steel wall forms. The small continuous mixer shown in the picture feeds into the boot of the elevator a mortar consisting of cement and coarse lake sand devoid of large aggregate. The walls of the one-story house are 4 in. thick and 9 ft. high. The plan dimensions are 20 x 34 ft.

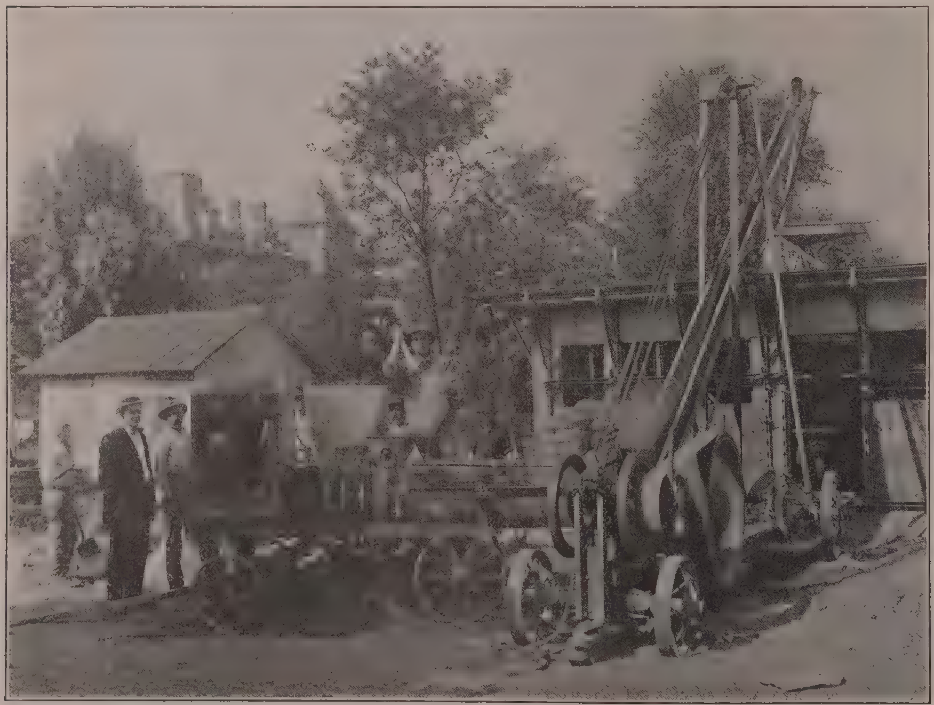
D. S. Humphrey, contractor and the inventor of the conveyor, has erected a two-story office building 25 ft. high with the outfit.

Reinforced-Concrete Work Well Handled on Chicago Sewer

IN A LARGE trunk sewer now being constructed in connection with the new Union Station in Chicago, the invert and side walls are concreted first to hold the reinforcing and the sides of the trench, so that the trench bracing which supports both may be removed to allow concreting the arch. Interior form braces are also eliminated by the use of a special design of Hydraulic pressed steel forms. The sewer, which is 9 x 12 ft. inside and 12 x 18 ft. outside, is of reinforced concrete and runs from Monroe and Clinton Streets east to Canal Street, and thence north on Canal to Washington Street and east on that street to the Chicago River.

The major portion of the bottom of the 12-in. invert, about 10 ft. wide, is laid directly on the soil without the use of forms. This section, which is laid first, furnishes a support for the ribs of the steel forms. Then the steel forms and reinforcing are placed and concrete poured to complete the invert. The sides and a section of the arch to the springing line are poured monolithic. This section of the concrete work is then allowed to set for a day. The outside steel forms for the arch are next braced against the bank. Then the 6 x 6-in. 12-ft. trench braces, seen in the accompanying photograph, are removed, and the work of setting forms and concreting the arch completed.

The small inside form sheets are removed by knocking out keys which hold them to the ribs. The ribs, which act as a brace to the new arch, are allowed to stand for 72 hr. before being removed. Four men put up and take down in a day a section of form work 20 ft. long. Of course, only a few minutes are required in taking the forms down. The rate of progress is measured by the rapidity of concreting. The W. J. Newman Company of Chicago is the contractor for the work.



NOVEL CONVEYOR OUTDOES EDISON IN BUILDING CONCRETE COTTAGES

Channel Blasted in Coral Rock Under Water by "Dobying"

A CHANNEL between Clearwater and St. Petersburg, Fla., 100 ft. wide and 8 ft. deep at low tide was recently blasted without drilling any holes in which to place the charges, according to the *DuPont Magazine*. The charges of dynamite were simply placed on the bottom, relying on the tamping effect of water over them to break up the rock. These shots did great execution on the fairly soft coral, and the cost of the extra dynamite used is said to have been more than balanced by the saving of labor in not drilling any holes, leaving the time saved in completing the channel a clear gain.

TWENTY MILES OF ELECTRIC RAILWAY have been completely constructed during the past year by the city of San Francisco. The city has acquired, constructed and equipped 43.6 miles of single track and has under consideration the immediate construction of an additional 5 miles.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Worcester Plans Road Congress

The Chamber of Commerce of Worcester, Mass., announces that an "International Road Congress" will be held in that city Dec. 14 to 17 inclusive. The convention hall will be in the Hotel Bancroft and an exhibit of road-building materials and equipment will be held in an adjoining auditorium. The Massachusetts Highway Association and the Federal Government will co-operate with the local authorities in conducting the meeting.

The first day, Dec. 14, at 2 p. m., will be Governors' Day and there will be addresses by the Governors of several New England States. Road Builders' Day is scheduled for Dec. 15 at 9 a. m. The sessions on Dec. 16 will be featured by addresses by the Mayors of Boston, Providence, and Montreal. The final day, Dec. 17, will be Automobile Day.

Among the engineers on the program for the congress are Logan Waller Page, Clifford Richardson, W. W. Crosby, Dr. Ira N. Hollis, George W. Tillson, H. L. Sherman, J. R. Worcester, W. A. McLean, Dr. Joseph H. Pratt, Nelson P. Lewis, W. H. Connell, George C. Diehl and William D. Sohier.

New York Authorizes Bond Issue to Complete Barge Canal

The final count of the votes at the election of Nov. 2 on the referendum authorizing a bond issue to complete the New York State barge canal shows a majority of about 25,000 in favor of the issue, according to results tabulated in the office of the State engineer. The plans for the uncompleted sections will be finished at once in order that it may be possible to award contracts just as soon as the money is available.

To Study Advantages of Use of Hydrated Lime in Concrete

To determine if the claims that the addition of hydrated lime to concrete increases its plasticity, decreases segregation and improves its waterproofing qualities are justified, the U. S. Bureau of Standards will make tests on such concrete. Before entering into the work an advisory committee, composed of representatives of the four interests involved—the cement industry, the lime industry, the engineer and the contractor—was asked to participate in outlining plans for the work. This committee, which was selected by P. H. Bates and W. E. Emley (of the Bureau of Standards), who will have active charge of the work, met in Pittsburgh, Nov. 4, and offered criticisms of the plan of work prepared by the Federal bureau. As a result the program was modified to meet such criticisms insofar as was advantageous, and it is expected that the research will be started during the present month.

As outlined, the work is extensive in scope. The tests will include: Determination of compressive strength, expansion, reinforcement, permeability, action of sea water, the hydration of cement, absorption, segregation, abrasion and adhesion of cement to reinforcement. Specimens to which varying proportions of hydrated lime have been added up to five years of age will be tested.

The advisory committee consists of Nathan C. Johnson of New York, Alfred H. White of the University of Michigan, S. C. Potts of the Pennsylvania Railroad System at Altoona and Dr. J. N. Mackall of the Maryland State Highway Commission, Baltimore, engineers; W. A. McIntyre of the American Association of Portland Cement Manufacturers, Ernest Ashton of the Lehigh Portland Cement Company, E. D. Beyer of the Atlas Portland Cement Company and W. M. Kinney of the Universal Portland Cement Company, representing the cement interests; W. E. Carson, president of the Lime Manufacturers' Association, Laurence Hitchcock, chairman of the executive committee of the Hydrated Lime Bureau, and N. G. Hough, manager of the Hydrated Lime Bureau, representing the lime interests; and the James L. Stewart Construction Company of Pittsburgh, W. L. Prettyman, president of the Concrete Construction Company of Philadelphia, and H. L. Smith, general manager of the Turner Construction Company of New York City, contractors.

New England Waterworks Officers for Ensuing Year Nominated

In a report submitted to the secretary of the association the committee of the New England Waterworks Association appointed for that purpose states that it has nominated the following officers for the ensuing year: For president, William F. Sullivan of Nashua, N. H.; vice-presidents, C. M. Saville of Hartford, C. E. Davis of Philadelphia, S. E. Killam of Boston, R. S. Lea of Montreal, Canada, D. A. Heffernan of Milton, Mass., and W. W. Brush of New York City; executive committee, R. C. P. Coggeshall of New Bedford, R. J. Thomas of Lowell and F. J. Gifford of Dedham, Mass.; secretary, William Kent of Narragansett Pier; treasurer, L. M. Bancroft of Reading, Mass.; finance committee, George H. Finneran of Boston, D. N. Tower of Cohassett, Mass., and John Mayo of Bridgewater, Mass.; editor, R. K. Hale of Boston, and advertising manager, G. A. King of Taunton, Mass.

Form Chicago Chapter of the American Association of Engineers

By-laws for the Chicago chapter of the American Association of Engineers which starts with a membership of 160 were adopted at a meeting held Nov. 5. In order properly to place the responsibility for the work to be accomplished by the chapter, fourteen standing committees are provided for. An idea of the scope of the work is given in the following committee titles: By-laws, meetings, program, entertainment, initiation, finance, inspection trips, publicity, articles for publication, membership, visiting, grievances, local legislation and employment and information. Chapters are being formed at Springfield, Ill., Minneapolis, Indianapolis and several other points.

In order to compensate for the effort required on the part of the pioneers in the association to establish "going value" a provision is to be made in the constitution providing that there be no fees other than annual dues until 500 members have been obtained, after which an initiation fee of $2 additional to the annual dues will be charged. The initiation fee is to increase with each 500 new members.

City Managers to Meet in Dayton

The City Managers' Association and two other municipal organizations, the National Municipal League and the Ohio Municipal League will meet in Dayton, Ohio, during the week of Nov. 15 to 19. On the program of the city managers on Nov. 15 and 16 are Fowler S. Smith on "Purchasing Methods," Karl Mitchel on "Municipal Cost Data," Charles E. Ashburner on "The Citizen and the New Form of Government," G. C. Cummin on "Budget Making," Winton Miller on "Publicity Work Necessary Under the New Plan" and Henry M. Waite on "Powers and Duties of the City Manager."

Eight Killed and Many Injured in New York Factory Fire

Horrors of Triangle Fire Repeated on Smaller Scale in Building with Unprotected Stairways and Only One Fire Escape

Unprotected stairways, despite an order issued as far back as January, an inadequate provision of fire escapes and a bolted door were responsible for the loss of life and the large number of injured in a fire that occurred, Nov. 6, in a factory building at 281-283 North Sixth Street, Williamsburg, New York City, in which there was a total absence of any provision such as a sprinkler system, fire drills or interior signal system that might have tended to lessen the effects of the disaster. That the casualities were not greater was due to the fact that, being a half-holiday, the usual number of workers were not in the building.

An inspector of the State Industrial Commission visited the building in January and discovered that the law was being violated inasmuch as the stairways, walls and ceilings of the exits were not fireproofed. An order to remedy the defects was served on the owner. In February it was not complied with. Several months passed and for some reason no notice of the violation was given the counsel of the State Industrial Commission until September. Legal steps were then taken to inforce the order, with the result that only three days before the fire the owner started to work on building fireproof partitions.

At the time the flames were first discovered there were about 200 persons in the buildings. In the first two floors, which were occupied by a candy manufacturing establishment conducted by Mr. and Mrs. Edward L. Diamond, the owners of the building, a very small percentage of the working force was on hand. On the third floor there were about 60 persons, on the fourth between 40 and 50 and on the top floor about 40. The first sign of fire came from the bottom of an unused elevator shaft. Almost simultaneously flames burst out on every floor.

At first the occupants made for an unprotected stairway that ran along the elevator shaft. Escape by this route was soon cut off by the stairway catching fire between the first and second floor. A locked trap door on the fourth floor prevented the escape of many by a side stairway.

The spread of the flames drove the workers back toward the windows, where a jam occurred, and, in consequence, a panic. Some made their way down the one fire escape. But even here the flames followed and enveloped them. Several were found dead on its iron platforms.

The known dead as a result of the disaster number eight and 36 were injured. Besides there are a number of missing, so the casualties may run higher. The owners of the building were arrested and later released on bail. Investigations are in progress to determine the responsibility.

There was no sprinkler system in the building, nor was there an interior fire alarm system. The testimony and findings to date indicate a total absence of any of the customary precautions generally recommended for such buildings.

Ohio River Dam Near Steubenville Completed and Put in Operation

Dam 10 in the Ohio River, about a mile above Steubenville, Ohio, was completed and put in operation Nov. 4. The total cost of the construction was somewhat over a million dollars.

Work in 46th Street Cofferdam, New York City, Well Along

The excavation for the two slips flanking New York City's new pier at Forty-sixth Street and the North River will soon be finished. The foundation for the portion of the pier within the cofferdam is more than half concreted, and the space between the outside concrete walls of the pier foundation is largely backfilled with excavated rock. The work of concreting the south wall of the south slip at the lower end of the cofferdam is also well along. As soon as the excavation is complete, the back walls of the two slips will be concreted, completing the work which requires pumping the cofferdam.

The rock to be excavated sloped upward toward the shore, and as soon as a face high enough to permit their use was reached, six well drills were installed. These drill holes to the bottom of the cut, and the face is blown down into the excavation in full-depth sections, as in quarry work. The holes are not sprung, however. The drills are shown in the accompanying photographs.

The large sound stone broken out are used in great numbers as plum stone in the heavier concrete sections. They are washed off with a hose one at a time as they are raised by the cranes to be swung into place.

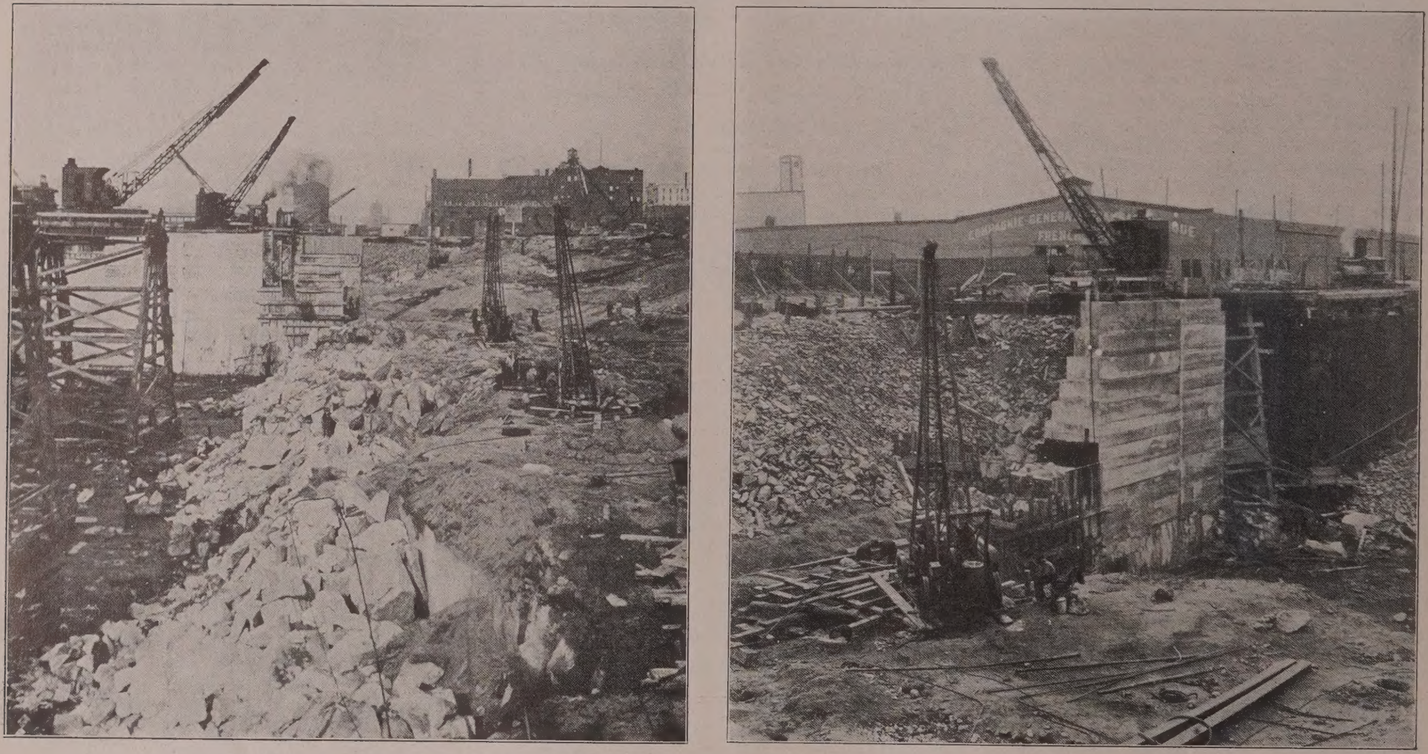
The pile portion of the pier is nearing completion, less than 100 ft. on the outer end remaining to be driven. This part of the work has been delayed by the difficulty of obtaining the 85-ft. piles needed for the river end of the pier. The pier is being built for the Department of Docks and Ferries of New York City, of which R. A. C. Smith is commissioner and C. W. Staniford chief engineer, by the Holbrook, Cabot & Rollins Corporation, for whom Daniel Hughes is in charge as superintendent under Thomas B. Bryson. A description of the design being carried out under this contract will be found on page 120 of the Engineering Record for Aug. 1, 1914.

The Bacon's the Thing

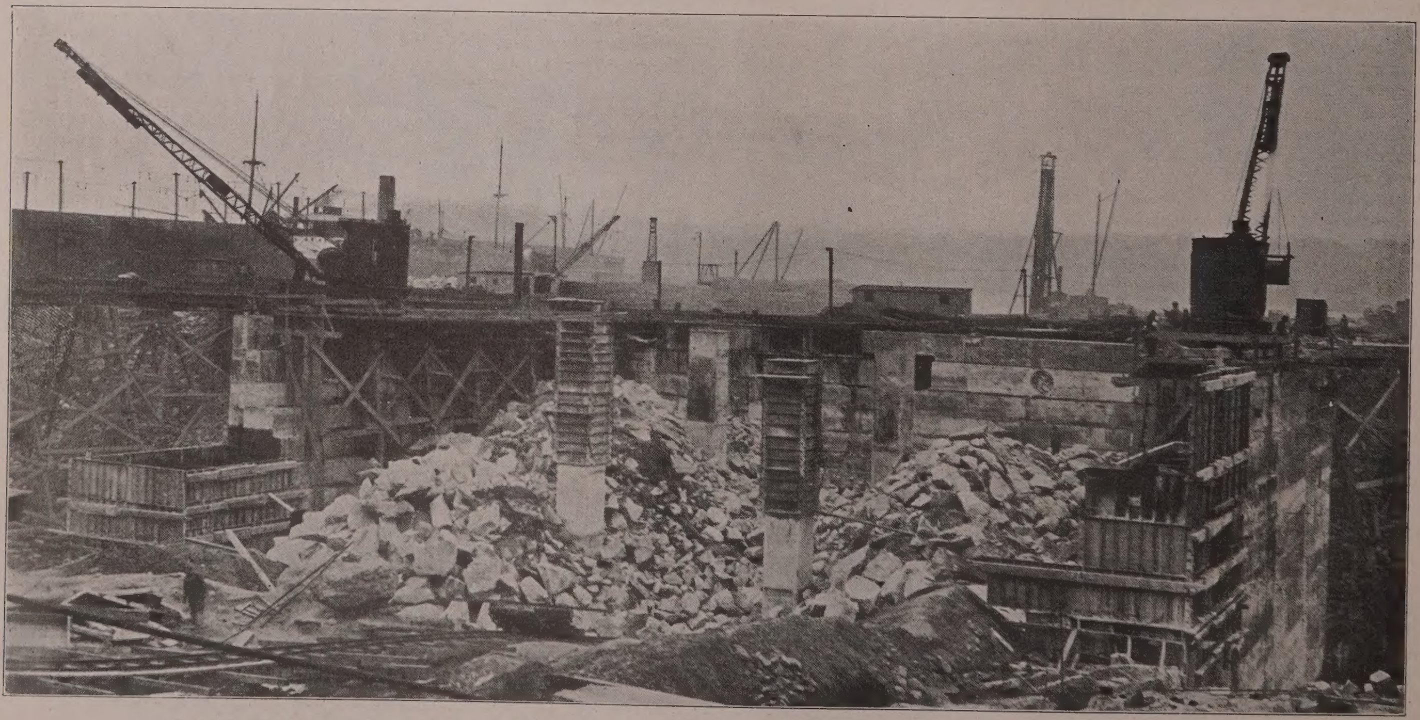
The frankest—and rawest—expression of pork-barrel sentiment we have heard in a long time is this from the Key West (Fla.) *Journal:*

"If you employed a man at a salary of $7,500 a year and allowed him an expense account in addition, you'd expect that man to produce results, wouldn't you? Florida is going to employ a man to represent her in the United States Senate next year. Let's employ a man that can 'produce.'"

A patriotic citizen of Florida whose indigna-



FACE OF ROCK EXCAVATION SHORTLY AFTER A BLAST AND SOUTH SLIP WALL IN LOWER CORNER OF COFFERDAM



CRANES AT WORK BACKFILLING FOUNDATION FOR SHORE END OF NEW YORK CITY'S NEW FORTY-SIXTH STREET PIER tion was aroused by the paragraph asks this pointed question:

"With a constituency that openly and shamelessly gives notice that he is to be employed to 'produce' what do you think will be the character of the services performed by a Senator elected with this understanding?"

He will do exactly what such people as the editor of the *Journal* want him to do. He will bring home all the "bacon" he can. With his eyes closed and his nose clasped tightly between two fingers he will vote for the off-color projects of other members of Congress in order to get all the cash he can for dams in Florida creeks and post-office buildings in Florida villages.—*Collier's*.

Aluminum Company Takes Over French Holdings in Plant

It is reported that the Aluminum Company of America has taken over the entire French holdings in the hydro-aluminum plant near Whitney, N. C., which, when completed, was, according to the original plan, to have cost $10,000,000. Formal transfer of its property is said to have taken place last week. It is understood that the new company will carry the construction to completion at once, expending for the purpose several millions of dollars. Work on the plant was originally started early in 1914, but ceased shortly after the European war broke out.

Unassembled Examination for Illinois Waterways Engineer

Because of the large number of competent applicants for the examination for waterways engineer recently announced in Illinois, who found it impossible to attend the examination in the State, the Civil Service Commission has postponed the examination and has issued a letter reannouncing it under different conditions. The substance of the letter is as follows:

It has been decided to make this examination an unassembled one as far as the written portion is concerned. This means that a set of questions concerning education, training and experience will be mailed to each applicant, which is to be filled out by him and returned to the commission at Springfield before some date, to be fixed later. This information, or examination, will be subject to correction by a board of examiners.

Those whose education and experience indicate that they would be able to handle the duties of the waterways engineer will be directed to assemble at some convenient point in Illinois for a personal interview with the board of examiners.

By this arrangement persons in distant parts of the country will be enabled to take the preliminary portion of the examination without going to any expense, while those who succeed in this preliminary portion may make the trip with a reasonable chance of being placed on the eligible list.

The questions will be mailed to applicants Dec. 1.

It has been announced by the new waterways commission of Illinois that action will be started early next spring on the deep waterway through the State.

News of Engineering Societies

The Washington Society of Engineers will hold a banquet Nov. 23 at Rauscher's, in Washington, D. C.

The Montana Institute of Municipal Engineers will hold its annual meeting at Billings Jan. 17-19, 1916. Carl C. Widener of Bozeman is secretary.

The Hydrated Lime Bureau will hold its first annual meeting at the Oliver Building, Pittsburgh, Dec. 1. It will be decided upon at the meeting whether or not the bureau will be continued. In case it is decided in the affirmative a definite program will be determined upon for the ensuing year.

The Engineers' Society of Western Pennsylvania will hear Thomas Fleming, Jr., of the firm of Chester & Fleming, consulting engineers of Pittsburgh, speak on "Improvements in the Art of Mechanical Filtration" at a meeting to be held in Pittsburgh Nov. 16.

The Cleveland Engineering Society will hold a special meeting Nov. 23 to hear W. H. Alexander, local forecaster of the U. S. Weather Bureau, speak on "What the United States Weather Bureau in California Is Doing for the Benefit of the Engineer."

The American Society of Agricultural Engineers will hold its annual meeting in Chicago Dec. 28-30. The papers to be presented cover, among other subjects, such matters as farm conveniences, including water and sewerage systems, drainage, irrigation and farm structures. F. M. White of Madison, Wis., is secretary of the society.

The Colorado Association of Members of the American Society of Civil Engineers will be addressed this evening by F. C. Steinhaur, superintendent of Denver mountain parks, on "The Construction of Automobile Highways in the Mountain Parks." L. R. Hinman, secretary, announces that hereafter the weekly noonday lunches are to be held at Clarke's restaurant.

The Yale Engineering Association held its first annual meeting in New Haven, Conn., on Nov. 5. The meeting was addressed by E. M. Herr, president of the association; Russell H. Chittenden, director of the Sheffield Scientific School; Arthur T. Hadley, president of Yale University, and by the heads of the engineering faculties of the school. The 160 members present visited the new Mason laboratory of mechanical engineering, the Hammond laboratory and other recent additions to the equipment of the School. Lunch was served in Memorial Hall. The purpose of holding the meeting in New Haven was to interest the members of the society in the advancement of engineering education.

The Carnegie Institute of Technology of Pittsburgh will celebrate Carnegie Day Nov. 23 and 24.

Personal Notes

H. W. MUDGE, formerly president of the Rock Island System has been elected president of the Denver & Rio Grande Railroad succeeding B. F. Bush.

EDWARD S. AULT, formerly connected with the Marion Steam Shovel Company of Marion, Ohio, has been appointed city engineer of that city.

WALTER N. POLAKOV has resigned as superintendent of power of the New York, New Haven & Hartford Railroad to engage in consulting practice. In the eighteen months he had charge of the operation of the power plants of the New Haven he effected a saving of 25 per cent in the cost of electric power. His address is Revonnah Manor, Stamford, Conn.

LEWIS W. BALDWIN, formerly general superintendent of all lines of the Illinois Central Railroad south of the Ohio River, has been appointed general manager of the Central of Georgia Railway, with headquarters at Savannah. He was graduated from Lehigh University in 1896 and entered railway service in the engineering department of the Illinois Central. He was appointed track supervisor in 1900 and, in the following year, became roadmaster of the Yazoo & Mississippi Valley Railroad. In 1902 he returned to the Illinois Central in a similar capacity and, in 1904, was promoted to the grade of trainmaster. Subsequently he served as superintendent on subsidiary lines. He attained the grade of engineer, maintenance-of-way in 1910 and that of general superintendent in the early part of the present year.

WILLIAM S. DOWNS, formerly resident engineer in charge of reservoir construction for the Hydroelectric Company of West Virginia, has been appointed county road engineer for Monongalia County, West Virginia, to have charge of the special road improvements in Morgan district, for which there is a $300,000 bond issue available.

HORACE M. BRINGHURST, formerly supervising draftsman for the Port of Seattle Commission, has been appointed draftsman for the McClintic-Marshall Company of Pittsburgh, Pa.

HUGH M. WILSON, first vice-president of the McGraw Publishing Company, was struck by an automobile while returning from the city to his home in Scarsdale on the evening of Nov. 5. The machine did not have its headlights burning. The first reports of the accident indicated that Mr. Wilson was seriously hurt. To allay the anxiety of the many friends who have inquired about him it can be said that while his injuries are painful they will not incapacitate him for any great length of time.

PAUL M. LINCOLN has resigned from his position in the engineering department of the Westinghouse Electric & Manufacturing Company to devote his time to the manufacture of a meter which he has recently invented. Up to July of this year Mr. Lincoln was president of the American Institute of Electrical Engineers.

LAWRENCE A. DOWNS, formerly superintendent of the Kentucky division of the Illinois Central Railroad, has been appointed general superintendent of all lines south of the Ohio River, with headquarters at New Orleans. He was graduated from Purdue University in 1894 and entered railway service in 1895 on the engineering forces of the Vandalia Railroad. He went to the Illinois Central in 1896 as assistant engineer in maintenance and construction. In 1898 he was appointed roadmaster on the Amboy division and, in 1907, he became assistant chief engineer of maintenance-of-way. He attained the grade of superintendent in 1910.

A. F. LOHR, formerly connected with the Buckeye Steel Castings Company, has been appointed deputy county engineer of Madison County, Ohio.

W. G. KIRCHOFFER, sanitary and hydraulic engineer of Madison, Wis., and consulting sanitary engineer to the State Board of Health has been appointed consulting engineer for the department of the State engineer of Wisconsin. This appointment was noted in the Oct. 30 issue of this journal but Mr. Kirchoffer's name was erroneously spelled.

A. S. MILLER, formerly city engineer of Lake City and county surveyor of Columbia County, Florida, has been appointed assistant engineer for the State Highway Commission of Iowa.

R. L. BALDWIN has resigned from the office of appraisal engineer for the State Utility Commission of Missouri to become associated with Burns & McDonnell, consulting engineers, of Kansas City. Mr. Baldwin, who is a graduate of Missouri State University, was associated with the same firm before becoming appraisal engineer for the utility commission. He held the latter office for two years. In his new connection he will have charge of the firm's electrical work and of appraisals of electrical and other utilities.

WILLIAM M. RUMSEY, formerly city engineer of San Diego, Cal., has opened offices in the Granger Building, San Diego to engage in private practice. He began his engineering work in 1887 in the building and contracting field and has since been engaged principally in irrigation and municipal work. He was in the service of the city of San Diego, as assistant city engineer and as city engineer for nine years.

C. F. LOWETH, chief engineer of the Chicago, Milwaukee & St. Paul Railway, has been elected a member of the engineering committee for the Western group, Presidents' Conference Committee, Federal Valuation of the Railroads in the United States.

F. P. GILBERT, formerly assistant sanitary engineer on the forces of the Maryland State Department of Health, has been appointed assistant superintendent of the water and sewerage systems of Freehold, N. J.

E. H. MAY, formerly assistant on the engineering corps of the Indianapolis division of the Pennsylvania Railroad Lines West of Pittsburgh, has been appointed assistant division engineer of the Michigan division of the Vandalia Railroad, with office at Logansport, Ind.

Obituary Notes

T. W. M. DRAPER, civil and mining engineer, of New York City, died Nov. 8, at the age of sixty-one years. He was born in New York and was educated in Germany and Switzerland. After serving as a volunteer in the Franco-Prussian War, he returned to the United States, where he engaged in work in Colorado. Later he was engaged on the construction of the Atlantic & Danville Railroad and, during the Spanish-American War, served as captain of engineers.

WILLIAM F. ALLEN, who devised the present method of computing standard railway time, died in South Orange, N. J., Nov. 9, at the age of sixty-nine years. He entered railway service in 1862, as rodman on the Camden & Amboy Railroad and rose to the grade of assistant engineer in its service. In 1868 he became resident engineer on the West Jersey Railroad and, in 1872, he was appointed assistant editor of the *Official Railway Guide*, Six months later he was appointed editor of the guide and, in 1914, he became president of the National Railway Publication Company which publishes it. He began working on standard time reckoning for railroads in 1881 and to-day the plan he devised is in use throughout the continent. In 1875 he assisted in the founding of the American Railway Association and, at the time of his death, he was its general secretary and treasurer.

EBEN R. DYER, superintendent for the last fifty years of the Portland (Maine) Water Company and the Portland Water District, died Nov. 8.

Civil Service Examinations

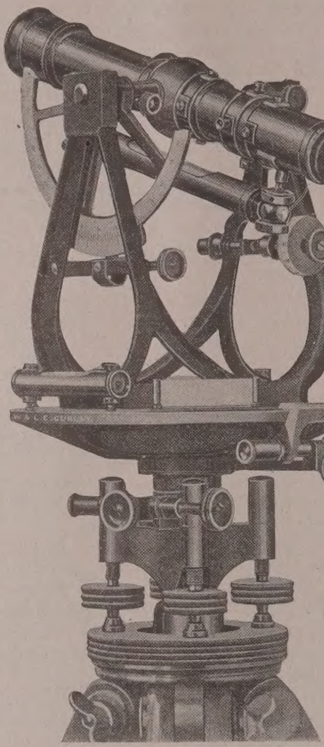
New York.—In the open-competitive examinations to be held within the State Dec. 11 it is announced that application forms must be duly executed and filed with the Civil Service Commission, Albany, by Dec. 1, and that no form will be sent from the office after Nov. 29. Furthermore, it is stated that in writing for forms the position for which the form is desired should be particularly specified.

Among the positions for which examinations are to be held are those for junior engineer, grade 7, salary from $1,201 to $1,500 a year; junior assistant, engineering department, salary from $901 to $1,200; structural draftsman, salary same as junior engineer, and junior draftsman, salary same as junior assistant.

Each of these positions requires technical training, the two superior ones especially. Experience up to two years gives any candidate for the lower positions who has met the other requirements preference, and is required of those candidates who take the examinations for the higher positions, unless they have had a certain definite college or university technical education. The age limit for the smaller jobs is 20 years, that for the other two being 21 years. Non-residents are permitted to take examinations for any of these positions, but will be subject to the civil service regulation, giving residents of the State preference.

New Type of Transit Has Beveled Limb and One Piece Standard

A transit that includes a new type of one piece trussed standard and a beveled, or "dished," limb has recently been put on the market by W. & L. E. Gurley of Troy, N. Y. The standard consists of a solid bronze casting, said to be of perfectly balanced symmetry. The limb is hollow and ribbed, increasing in depth from the outer edge toward the spindle and socket. The plate is heavily ribbed.



BEVELED LIMB A FEATURE OF THIS TRANSIT

Water Softening Zeolite Found in Black Hills

Following the discovery of a water softening zeolite in the Black Hills, North Dakota, and a year of experiments, a company has been formed in Des Moines, Iowa, to place it on the market under the name of Refinite. The material is reduced to particles about the size of rice grains and then put through a bake oven. It is used as a filtering media in a simple mechanical filter. After a definite quantity of lime and magnesia has been stored up a solution of common salt is passed through the filter to restore the water softening properties of the zeolite.

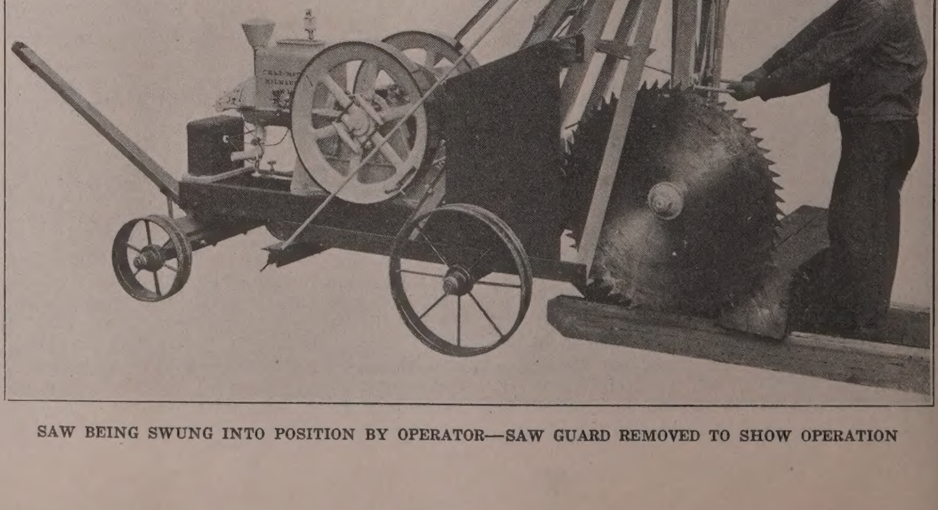
An installment has been operating for more than two months in the home of Charles S. Denman, manager of the Des Moines Water Company. R. N. Kinniard, chief engineer of the water company, is chief engineer and manager of the Des Moines Refining Company, which will handle the zeolite. He states that it is entirely feasible to soften the entire water supply of Des Moines but that probably the consumers would not stand for the additional cost, 75 cents to $1 annually. Plants for residences can be installed, however, for from $150 to $500.

How England's Export Trade Is Fostered and Directed

In the recent publication of the Bureau of Foreign and Domestic Commerce, Department of Commerce, describing the system constituting the commercial activity of the United Kingdom and the methods and manner in which the Government fosters and directs trade expansion, Archibald J. Wolfe, the author, who personally investigated the work, has included lists of British chambers of commerce, discussions of their organizations and functions and accounts of State-aid methods to trade and manufacturers' and employers' associations. The booklet, which is entitled "Commercial Organization in the United Kingdom," and contains 53 pages, may be obtained by applying to the Superintendent of Documents, Washington, D. C., sending five cents and asking for pamphlet 102, Special Agents' series.

Saw for Cutting Heavy Timbers Can Be Moved on the Job

For cutting heavy timbers to be used in the construction of trestles, cofferdams, mill buildings and work of like character requiring a large size power saw, a 30-in. portable swing cut-off saw has been placed on the market. The saw can be easily moved around the job—the entire apparatus weighing 1800 lb. Power is furnished by a 6-hp. engine. The saw which is hung on a swinging steel frame is pulled by the operator through the timber to be cut. In the accompanying photograph the guard which is furnished for the saw has been removed so that the method of operation can be more easily illustrated. The new machine is manufactured by the C. H. & E. Manufacturing Company, Milwaukee.



SAW BEING SWUNG INTO POSITION BY OPERATOR—SAW GUARD REMOVED TO SHOW OPERATION